Rock Island Silicon Plant (Former) Sampling and Quality Assurance Plan Rock Island, Washington

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Prepared for:
United States Environmental Protection Agency
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SAMPLING AND QUALITY ASSURANCE PLAN FOR:

Rock Island Silicon Plant (Former) Site Rock Island, Washington

Contract Number: EP-S7-06-02 Technical Direction Document Number: 12-05-0002

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Acronym	<u>Definition</u>
AC	Analytical Coordinator
AST	American Silicon Technologies
bgs	below ground surface
CLP	Contract Laboratory Program
DDE	1,1-dichloro-2,2-bis(p-chlorophenyl) ethylene
DDT	dichlorodiphenyltrichloroethane
DOH	Washington State Department of Health
DQI	Data Quality Indicator
DQO	Data Quality Objective
DSHS	Washington State Department of Social and Health Services
E & E	Ecology and Environment, Inc.
EP	Extraction Procedure
EPA	United States Environmental Protection Agency
FOWP	Field Operations Work Plan
GIS	Geographical Information System
GPS	Global Positioning System
IDW	Investigation-derived waste
LCS	Laboratory Control Samples
μg/L	micrograms per liter
MCL	Maximum Contaminant Level
MEL	Manchester Environmental Laboratories
mg/L	milligrams per liter
mg/kg	milligrams per kilogram
MTCA	Model Toxics Control Act
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
QA	Quality Assurance
QC	Quality Control
PA	Preliminary Assessment
PE	performance evaluation
PCBs	polychlorinated biphenyls
PL	Project Leader
PM	Project Manager
PO	Project Officer
ppb	parts per billion
ppm	parts per million
PUD	Public Utility District

List of Abbreviations and Acronyms (cont.)

PVC	polyvinyl chloride
QA	Quality Assurance
QAM	Quality Assurance Manager
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
QMP	Quality Management Plan
RPD	Relative Percent Difference
RSCC	Regional Sample Control Coordinator
SCP	Specialty Chemical Products, LLC
SDMS	Sample Data Management System
SHA	Site Hazard Assessment
SI	Site Inspection
SIS	Sample Identification System
SOP	Standard Operating Procedures
SOW	Statement of Work
SPAF	Sample Plan Alteration Form
SQAP	Sampling and Quality Assurance Plan
START	Superfund Technical Assessment and Response Team
SVOC	semivolatile organic compounds
TAL	Target Analyte List
TCLP	Toxicity Characteristic Leaching Procedure
TDD	Technical Direction Document
TDL	Target Distance Limit
TM	Task Monitor
UST	underground storage tank
VOC	Volatile Organic Compound
WSU	Washington State University

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Project Description

This section defines the objectives and scope for performing Site Inspection (SI) activities at the Rock Island Silicon Plant (Former) Site. The main goals for the SI activities are as follows:

- Collect and analyze samples to characterize the potential sources discussed in Section 1.5.1.1;
- Determine potential for off-site migration of contaminants;
- Provide the United States Environmental Protection Agency (EPA) with adequate information to determine whether the site is eligible for placement on the National Priorities List (NPL); and
- Document a threat or potential threat to public health or the environment posed by the site.

The SI site assessment process does not include extensive or complete site characterization, contaminant fate determination, or quantitative risk assessment of a site.

1.1 Problem Definition

Pursuant to EPA Superfund Technical Assessment and Response Team (START) -3 Contract Number EP-S7-06-02 and Technical Direction Document (TDD) Number 12-05-0002, Ecology and Environment, Inc. (E & E), will perform a Site Inspection (SI) at the Rock Island Silicon Plant (Former) Site, which is located in Rock Island, Washington. The SI will consist of limited sampling at potential contaminant source and target areas. This document outlines the technical and analytical approaches E & E will employ during SI field work. This document is a combined field operations work plan (FOWP) and site-specific quality assurance project plan (QAPP) for field sampling activities. The combined FOWP/QAPP, hereafter called the Sampling and Quality Assurance Plan (SQAP), includes a brief site summary, project objectives, sampling and analytical procedures, and quality assurance (QA) requirements that will be used to obtain valid, representative field samples and measurements. The SQAP is intended to be combined with information presented in E & E's (2010a) quality management plan (QMP) for Region 10 START-3. A copy of the QMP is available in



E & E's office located at 720 Third Avenue, Suite 1700, Seattle, Washington 98104. This SQAP contains all QAPP elements as described in the EPA Agencywide Quality System Document Requirements for QAPPs (QA/R-5) (EPA 2001) and Guidance for Quality Assurance Project Plans (QA/G-5) (EPA 2002). The table of contents, however, reflects a rearrangement of sections for ease of use by field team

1.2 Site Background

1.2.1 Site Location

Site Name:	Rock Island Silicon Plant (Former)
CERCLIS ID Number:	WAN001002939
Site Address:	100 S. 4 th Street, Rock Island, Washington
Latitude:	47° 22' 13.50 North
Longitude:	120° 08' 24.34 West
Legal Description:	Township 22 North, Sections 25 and 26, Range
	21 East
County:	Douglas
Congressional District:	4
Site Owner(s):	Columbia Ventures Corporation
Site Operator(s):	Specialty Chemical Products, LLC
	100 S. 4 th Street, P.O. Box 68
	Rock Island, WA 98850
Site Contact(s):	James Trunzo, Columbia Ventures Corporation

1.2.2 Site Description

The Rock Island Silicon Plant is located within the city limits of Rock Island, Washington (Figure 1-1). The former silicon plant is approximately 7 miles east of the city of Wenatchee on State Highway 28. The plant site is located on a crescent shaped parcel of land totaling 58 acres, and is bounded by the Columbia River to the south and the main line of the Burlington Northern Railroad to the north. Site features are depicted on Figure 1-2.

The site is located in an industrial area; areas across State Highway 28 are commercial and residential, including agricultural areas used as fruit orchards.

The site consists of a raw materials building and stockpile area, former processing buildings (including furnace building, silicon storage building, and several other storage buildings), waste disposal area, eight fume settling ponds, and fume storage area. Piles of material from furnace cleaning activities are stored in concrete storage bays on site, located southwest of the furnace building. Access roads lead to a building used for offices. A trailer is located near the site of the former quality control (QC) laboratory where QC monitoring was conducted while the plant was producing silicon. A former drywell was associated with the former QC lab. A former transformer area is located north of the furnace building (see Figure 1-3). There are two water supply wells (Well No. 2 and Well No. 3) on site for non-potable uses.



1.2.3 Site Ownership History

The United States Department of Defense built the facility in 1942 during World War II. During this time, the plant was operated by Ohio Ferro Alloys (Ecology 2009).

The plant was purchased in 1948 by Keokuk Electro Metals. In 1959, Keokuk merged into Vanadium Corporation of America, which in turn merged with Foote Mineral in 1967 (Ecology 2009).

The plant subsequently was purchased from Foote Mineral by the Hanna Mining Company, now M.A. Hanna Company, in 1974 (Ecology 2009).

In 1988, Silicon Metaltech obtained ownership and operated the facility until 1993, when ownership changed to American Silicon Technologies (AST). Specialty Chemical Products, LLC (SCP), a subsidiary of Columbia Ventures Corporation, purchased the plant in 2001 and began using the facility for small-scale pilot plant experimentation with a small laboratory in support of the operation (Ecology 2009).

1.2.4 Historic and Current Site Operations 1.2.4.1 Current Operations

Currently, SCP operates a pilot plant and a small laboratory for the purpose of developing technology to produce amorphous precipitated silica using silica fume. Silica fume was a by-product of silicon and ferrosilicon metal production which formerly took place on the property. SCP is planning to recycle the silica fume that is currently stored on site (Ecology 2009).

SCP currently has a National Pollutant Discharge Elimination System (NPDES) permit (Permit No. WA-000286-1) for discharging non-contact cooling water into the Columbia River. The permit was issued by the Washington State Department of Ecology (Ecology) in April 2009 as a renewal for a previous permit issued in 1986. The permit allows for the operation of a single outfall which extends approximately 1,400 feet into the Columbia River from the left bank of the river (see Figure 1-2). Constructed before the river level rose following completion of a second powerhouse at the Chelan County Public Utility District's (PUD's) Rock Island Dam, the 18-inch corrugated steel outfall pipe is embedded 5 feet below the river bottom in a trench surrounded by imported trench backfill. The outfall has a diffuser that consists of ten 2.5-inch steel risers spaced 8 feet apart. The risers extend one foot above the bottom of the river. The permit requires monthly monitoring for pH and temperature (Ecology 2009).

Catch basins on site were previously tied into the non-contact cooling water outfall on the Columbia River, but the outfall has been closed and storm water connections to it have been cut off. A newly constructed swale near the former QC laboratory currently collects some storm water runoff from paved areas near



the offices. The site manager indicated that runoff from the remainder of the site infiltrates the ground.

Piles of material composed of carbon and silica metal from furnace cleaning activities (also known as hard pan and carbon block), are stored in concrete storage bays until it can be sold to a steel mill.

1.2.4.2 Historical Operations

Ohio Ferro Alloys began operation at the plant in 1942, producing pig iron and ferrosilicon until the end of the World War II. Ferrosilicon is a combination of silicon and iron, which is used in metallurgical industries. The plant was purchased in 1948 by Keokuk Electro Metals Company, which rebuilt the operation's furnaces and added a fourth furnace. As the demand for ferrosilicon on the West Coast began to diminish in the early 1950's, the plant turned to the production of silicon metal. The market existed at this time because large aluminum producers were constructing facilities in the area to take advantage of low-cost hydroelectric power (Ecology 1999).

Subsequent owners (Vandium Corporation, Foote Mineral, Hanna Mining Company, and Silicon Metaltech) continued operating the plant and producing silicon metal (Ecology 1999). Air emission controls (hooding, ducting, and baghouse) were installed by Hanna Mining Company in 1975 (Ecology 1999). AST operated the plant from 1993 until September 1999, producing silicon metal, which was used as an alloying element in other metallurgical industries, such as the aluminum industry (Ecology 2009).

When the plant was producing ferrosilicon, iron scrap was added to the furnace feed. Prepared raw materials consisting of powdered or granular coal, charcoal, coke, silica sand (or crushed quartz), and a binder material may have also been used, and would have been delivered to the plant in briquette form (Ecology 2009). Raw materials were delivered to the plant's storage yard or conveyed directly into a raw materials preparation building. These materials were then fed into individual batch hoppers, moved across scales, and conveyed to the electric arc furnaces (ERM-Northwest 1988a).

The materials were heated in the furnace to a temperature as high as 6,000 degrees Fahrenheit (°F) using the application of high voltage electrical power via carbon electrodes and heat produced by chemical reactions. The heat caused the smelting reactions to take place. Molten metal, at 3,000°F when tapped from the furnace, flowed into a ladle with a capacity of 3 tons. Final refining took place in the ladle to remove impurities. The molten metal was then poured into "casting dishes."

After cooling, the metal casts were broken in pieces, weighed, graded, and then stored. The metal was then crushed and screened to meet customer size requirements. Silicon metal was shipped in bulk, in jumbo sacks, or in palletized wooden boxes (ERM-Northwest 1988a).



The plant also had a silica fume bagging facility. This operation stored, classified (by size), and packaged silica fume collected by the air pollution control system on the furnaces. The material was packaged in bags or shipped in bulk by truck or rail.

Another by-product produced by the plant was dross (impurities removed during the smelting process), including dross collected from ladle and casting dishes, plus silicon or ferrosilicon product fines (ERM-Northwest 1988a). Dross and fume particles were mixed with water to form a slurry that was pumped through piping to a series of fume settling ponds on site (Farallon Consulting 2008).

The fume was deposited on site from 1974 through 1980; and from 1980 through 1988 approximately 85% of the 35 to 40 tons of fume generated each day had been collected and marketed for various applications, such as concrete amendment. The remainder, which consisted of particulates too small to be recovered, recycled, or marketed, was slurried and deposited on site in one of several unlined fume settling ponds. Estimated depths of ponds range from about 1.5 to 11 feet from the surface of the fume material (ERM-Northwest 1988a).

The fume pond system comprised eight settling ponds (Ponds 1 through 8, as shown on Figure 1-2). The ponds were generally developed by filling existing topographic depressions with fume slurry, and ponds were added as more fume was produced. Ponds were allowed to dry out, and the dried fume was excavated and transferred to the fume storage area. Excavated ponds would then be used to deposit more fume slurry (Farallon Consulting 2008).

By 1991 the plant had produced 13,076 tons of silicon metal (which is 98.9 percent silicon), 1,364 tons of dross, and 3,357 tons of fume (EEC 1992).

Additional by-products of the smelting process are carbon block and hard pan. These refer to materials that accumulate on the lining of the furnaces and require periodic removal. Carbon block and hard pan were stored in bins on site, as they could be recycled and sold for use in the steel industry (EEC 1991b).

The facility's air emissions were once regulated under the Chelan Douglas County Health Department; however, three air pollutants (particulate matter, sulfur dioxide, and carbon monoxide) were emitted by this facility at rates greater than the 100 tons per year threshold, and this necessitated an Ecology air operating permit in 1991 (Ecology 1999).

Ecology issued three notices of opacity violations to AST in 1993 and 1994, and the EPA issued a fourth notice in 1994 (Ecology 1998). For 1996, emissions of particulate matter were 1,068.6 tons per year, of which 936.7 tons per year were particulate matter less than 10 microns in size, according to the air operating permit application submitted by AST. Also for 1996, emissions of sulfur oxides as sulfur dioxide were reported as 670.8 tons per year, and carbon monoxide



emissions were 463.1 tons for the same year. The application reported 0.2 ton per year of lead was emitted, and no nitrogen oxides or volatile organic compounds (VOCs) were emitted. In 1998, AST reached a settlement with Ecology regarding historic air quality conditions. AST had submitted an air operating permit application in 1995; however, the permit underwent several drafts and revisions before final approval in May of 1999. The 1999 air operating permit indicated that AST included sampling data in the air permit application that showed that the particulate matter from the furnaces was emitted as amorphous silica, with no crystalline silica emitted (Ecology 1999). In September of 1999, AST ceased operations due to financial reasons. In February of 2001, Ecology rescinded AST's sir operating permit and permission to operate (Ecology 2001)

1.2.5 Previous Site Investigations

The following subsections discuss previous environmental investigations that have been conducted at the Rock Island Silicon Plant site.

1.2.5.1 Rock Island Arsenic and Selenium Update, 1980

In October 1980, Ecology published a memo concerning arsenic and selenium in Rock Island, Washington. According to the memo, fly ash (fume) from the Hanna Mining Company in Rock Island was found to have high concentrations of arsenic, selenium, cadmium, lead, and mercury. Further, ponding of the fly ash was considered to possibly pose serious environmental and public health problems. The memo also indicated that a Washington State University (WSU) study had found high levels of arsenic and selenium in the ground water of Rock Island (Ecology 1980). Ecology collected a sample of water from a fume settling pond for arsenic analysis. Arsenic was detected at a concentration of 3.9 milligrams per liter (mg/L). As a result of this analysis, Ecology requested that Hanna Mining Company install ground water monitoring wells to determine if metals were leaching from the ponds to the ground water (Ecology 1980).

1.2.5.2 Hanna Mining Company Ground Water Sampling Program, 1982

In 1982, at the request of Ecology, Hanna Mining Company installed monitoring wells to determine if fume settling ponds were impacting ground water at the site. Two shallow ground water monitoring wells were installed. MW1 was 36 feet below ground surface (bgs) and was located downgradient of a fume settling pond. MW2 was 29 feet bgs and was located upgradient of the fume settling pond. Locations of the former monitoring wells (MW1 and MW2) are shown on Figure 1-3.

Hanna Mining Company collected ground water samples from these wells for analysis of certain metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver) six times over a period of eight months. Only one analyte (cadmium) was detected above the Model Toxics Control Act (MTCA) Method A cleanup levels for ground water. Cadmium was detected in a single ground water sample collected from MW1 during the June 1982 sampling event. The cadmium level was not confirmed in the three prior or two subsequent ground water



summarized below:

monitoring events. No other analytes were detected at concentrations above MTCA Method A cleanup levels for ground water (Farallon Consulting 2008). Ecology agreed, in a memo dated October 1, 1982, that no contamination of shallow ground water in the area of the waste disposal lagoons was observed, and that sampling could be discontinued (Ecology 1982).

1.2.5.3 Environmental Audit of M.H. Hanna Company, July 1988 In 1988, a property pre-acquisition environmental audit of the plant was conducted by ERM-Northwest, Inc. for Silicon Metaltech, Inc. to ascertain whether environmental issues were present. Findings of this audit are

- Air Quality: The audit report indicated that the Hanna facility had prior air pollution control violations due to excessive dust emissions; these violations resulted in a consent agreement with Ecology.
- Surface Water Quality: The facility was operating under a NPDES permit for non-contact cooling water. The non-contact cooling water discharged via an outfall on the Columbia River and was monitored for temperature and pH. No violations had been reported.
- **Ground Water Quality:** Ecology had requested that Hanna Mining Company install two monitoring wells on site (as summarized in Section 2.5.2). Results of the ground water sampling and analysis program, which was undertaken from February through July of 1982, were compared to EPA primary drinking water standards, and did not indicate ground water contamination.
- Onsite Waste Disposal: The Hanna Mining Company facility produced fume waste from the baghouses, baghouse bags, and furnace waste from annual maintenance. These wastes were dumped on site. The fume was deposited in a series of ponds.
- Furnace Waste: Furnaces were shut down once per year for maintenance and repair. During this annual maintenance, approximately 35 tons of waste materials were produced.
- Underground Storage Tanks: At the time of the 1988 report, there were two underground storage tanks (USTs) at the facility. The tanks included a 4,000-gallon fuel oil tank for the boiler and a 1,000-gallon leaded gasoline tank for filling company vehicles. According to the site manager, there was another 20,000-gallon diesel tank that had been removed in 1986 (see Figure 1-3) (ERM-Northwest 1988a).

1.2.5.4 Post Environmental Audit Site Characterization, 1988

Silicon Metaltech requested additional work to address issues identified during the property pre-acquisition environmental audit. A report by ERM-Northwest, Inc. dated December 1988, presents the results of this work.



Additional work included tank integrity testing for two USTs that were in use at the time of the audit (determined to be in good condition), and the collection of soil samples from areas adjacent to and underlying the two USTs that were in use, as well as from the location of a removed UST. Also included in this work were sampling and analysis of:

- Soil underlying the laboratory drywell discharge;
- Soil underlying the former transformer;
- Fume settling ponds and the fume storage area to determine hazardous characteristics;
- Process cooling water discharged to the Columbia River; and
- Ground Water from MW1 and MW2 (i.e., the ground water monitoring wells installed in 1981, see Section 2.5.2).

Sample locations for fume settling ponds and the fume storage area are shown on Figure 1-3. Specific sample locations for other soil samples were not provided in the report; however, the locations of known sample positions are shown (former drywell, former transformer area, USTs, and former USTs).

Soil samples taken from areas adjacent to and underlying the three USTs (two present and one former) were analyzed for three priority pollutant hydrocarbons: benzene, toluene, and xylene. Results indicated that benzene, toluene, and xylene were not detected. Detection limits were 11 parts per billion (ppb).

Soil underlying the laboratory drywell was sampled and analyzed for VOCs, semivolatile organic compounds (SVOCs), pesticides, polychlorinated biphenyls (PCBs), and Target Analyte List (TAL) metals. Results indicated the presence of two phthalates (bi-n-butyl phthalate and bis[2-ethylhexyl]phthalate), at concentrations of 190 ppb and 100 ppb, respectively. Four samples exhibited elevated levels of mercury, ranging from 35 to 4,000 parts per million (ppm), and somewhat elevated lead, ranging up to 160 ppm. Lead and mercury contamination was present within a zone along the clay drywell outflow drain pipe. No other analytes were detected.

Soil in the former transformer area was found to contain PCBs at levels of concern. Samples of soil collected near the transformer area had 4 ppm and 6.1 ppm total PCBs.

Fifteen fume waste samples were collected from fume ponds and fume waste areas. Samples were collected from 0 to 3 feet below the surface using a post hole digger. For Ponds 1, 2, and 6, two samples were collected from each fume pond and composited for analysis. For ponds 3, 4, and 5, one sample was collected from each pond. Samples from ponds 4 and 5 were composited for analysis. Samples were also collected from the fume storage area on site.



Development of the sampling plan involved consideration of the relative ages of the fume ponds, since different fume ponds were in use at different times throughout the history of the site. These samples were analyzed for TAL metals and results were used to determine that the fume waste did not meet the definition of dangerous waste, as defined by Washington State regulation WAC 173-303.

A sample of the plant's effluent discharge to the Columbia River was collected and analyzed for SVOCs, VOCs, PCBs, pesticides, and TAL metals. Analytes detected included copper at 0.089 ppm, nickel at 0.008 ppm, and zinc at 0.002 ppm. These values did not exceed EPA secondary drinking water standards (ERM-Northwest 1988b).

According to the conclusions of this report, fume waste did not appear to meet the definition of dangerous waste, as defined in Washington State Dangerous Waste Regulations, and the effluent discharged into the Columbia River did not exceed EPA secondary drinking water standards. The report concluded that contaminants which could contribute to ground water contamination were not present in the fume waste at levels of concern relative to State of Washington Dangerous Waste Regulations (ERM-Northwest 1988b).

Ground water samples were collected from two onsite monitoring wells (MW1 and MW2), which were installed in 1981 (see Section 2.5.2). Samples were submitted for analysis of arsenic, cadmium, lead, mercury, and selenium. Arsenic levels detected in ground water samples from onsite wells ranged from <0.002 to 0.004 mg/L. No analytes were detected above EPA Maximum Contaminant Levels (MCLs).

The report indicated that ground water generally flows from the northwest toward the southeast, and that hydrogeologic conditions may occur during certain times of the year during which the ground water beneath the site may flow in a north to northeasterly direction, toward the town of Rock Island and the private and municipal water supply well located in that area (ERM-Northwest 1988b).

1.2.5.5 Characterization of Mercury in Soil/Fill at Silicon Metaltech, Inc., 1989

In August 1988, soil in the drywell area adjacent to the QC laboratory (Figure 1-3) was sampled. Soil samples indicated that some soil or fill was contaminated with mercury in the area underlying the former QC laboratory. The contamination appeared to be limited to a zone lying along the clay drain pipe extending from the laboratory drywell (ERM-Northwest, Inc. 1989). The drain pipe and 13 cubic feet of surrounding soil were removed and placed in wooden crates lined with plastic. The report recommended further remediation of this area to reduce mercury levels. At the time of this investigation, mercury had not been used at the plant QC laboratory in significant quantities since the 1960s. The report concluded that the mercury found in soil at the drywell did not appear to be the result of an ongoing release to the environment (ERM-Northwest, Inc. 1989).



START obtained copies of Uniform Hazardous Waste Manifests, dated April 27, 1992, which indicated that contaminated soil was disposed of off-site by Chemical Waste Management of the Northwest (CWM 1992).

1.2.5.6 Underground Tank Closure, 1990

In 1990, Environmental Engineering and Consulting, Inc. (EEC) monitored and documented the removal of a 1,000-gallon capacity unleaded gasoline UST. Soil samples were analyzed for total petroleum hydrocarbons and benzene, toluene, and xylene. The report on the removal indicated that soil in the vicinity of the tank excavation was not contaminated by residual petroleum hydrocarbons or benzene, toluene, and xylene (EEC 1990).

1.2.5.7 Laboratory Testing of Fume Waste via the Toxicity Characteristic Leaching Procedure (TCLP) Method, 1991

A letter from Mr. Patrick Wicks, EEC, to Mr. Jim Trunzo, Silicon Metaltech, dated April 17, 1991, describes results of fume waste samples. Five fume samples were collected by EEC and submitted for analysis of Toxicity Characteristic Leaching Procedure (TCLP) metals and TCLP SVOCs. Results showed that no samples exceeded the EPA TCLP regulatory limits (EEC 1991a).

1.2.5.8 Carbon Block and Hard Pan Furnace Wastes Analytic Data Summary, 1991

A letter report, dated May 2, 1991, provides results of testing of carbon block and hard pan at the site. Carbon block and hard pan are by-products of the smelting process which build up as a lining of the furnace and which were periodically removed. Carbon block and hard pan were stored in storage bins on site. Testing of carbon block and hard pan samples was recommended by ERM-Northwest, Inc. in 1988 to assess whether any wastes disposed in the onsite piles were hazardous waste. The letter includes the results of samples collected from a furnace during a 1988 maintenance overhaul. Since all furnaces process the same materials, these samples are assumed to be representative of all carbon block and hard pan at the site. The letter states that laboratory results indicated the carbon block and hard pan had levels of metals similar to background soil, although chromium was higher in the carbon block sample. Based on these results, the letter concluded that the carbon block and hard pan would not be classified as hazardous under the Extraction Procedure (EP) toxicity test (EEC 1991b).

1.2.5.9 Site Hazard Assessment, Silicon Metaltech Inc., 1991

In May 1991, Science Applications International Corporation conducted a Site Hazard Assessment (SHA) for Ecology. The SHA included an interview of a site representative to determine the processes related to the fume waste ponds and an inspection of the area where mercury contaminated soil had been removed. The bulk of the mercury contaminated soil had been removed, placed in plastic-lined crates, and was being stored near the fume waste pond directly west of the furnace building. The SHA recommended that the mercury-contaminated soil be disposed of off-site (SAIC 1991).



1.2.5.10 Environmental Due Diligence Report, 1992

In 1992, an environmental due diligence report was prepared by EEC for Mr. Kenneth Peterson of AST for the purchase of the site. Environmental issues identified during this assessment included the following:

- USTs: There was one active 5,000-gallon UST used for boiler fuel. Results of a 1988 tank tightness test and subsurface soil sampling indicated no apparent leakage from the tank. This tank was exempt from UST regulations since it was used for onsite heating fuel. Two additional USTs were previously removed from site in 1988 and 1989, and subsurface soil testing indicated no apparent leakage from either tank.
- Laboratory Drywell: The cleanup of mercury contamination found at the QC laboratory drywell had not been completed. For this reason, Silicon Metaltech, Inc. had been listed as a contaminated site in Ecology's database.
- **PCBs:** A corrective action for this contaminated area was recommended in 1988, but no remedial actions had been taken related to PCBs.
- Fume Hazardous Waste Determination: Fume waste was tested in 1991 using TCLP analysis, and was determined not to be a hazardous waste (EEC 1992).

1.2.5.11 Department of Health Investigation Letter, 1993

A 1993 letter from the Washington State Department of Health (DOH), Office of Toxic Substances to Ecology, Toxics Cleanup Program, indicated that the DOH had conducted a health investigation of Silicon Metaltech Inc. DOH concluded that the site did not present a significant hazard to public health (DOH 1993). A copy of the original DOH investigation was not available.

1.2.5.12 Fume Characterization Summary Report, 2008

This summary of fume characterization activities was prepared by Farallon Consulting in October 2008 to address concerns expressed by Ecology in 2008 regarding potential health or environmental risks from fume material at the SCP facility. Ecology expressed these concerns as part of an evaluation of a request by SCP to terminate coverage of the NPDES permit (Farallon Consulting 2008). Fume material and ground water characterization, as well as conclusions of this report, are presented below:

■ Fume Material Characterization: The fume material was sampled and analyzed for various metals by ERM-Northwest, Inc. in 1988 (as described in Section 1.2.5.4). Eight samples were collected from 15 locations (FW2 through FW16) in the fume ponds and fume storage area (see Figure 1-3 for sample locations). Material from some locations was composited, based on the relative age of the deposited materials. Total chromium and cadmium were the only metals detected at concentrations above MTCA Method A cleanup levels in the 1988 fume samples. A summary of analytical results is



presented in Table 1-1. The pH of the fume material was neutral to slightly basic, ranging from 8.84 to 7.80.

Twelve fume leachate samples were also analyzed between 1988 and 1996, with no analytes detected above EP Toxicity or TCLP regulatory screening levels. A summary of EP Toxicity and TCLP analytical results is presented in Table 1-2. Results of a bioassay test conducted using a sample of the fume slurry discharge in July 1996 using 30 rainbow trout did not express a toxic effect.

■ Ground Water Characterization: In April 1981, Hanna Mining Company installed two shallow ground water monitoring wells under the direction of Ecology (MW1 and MW2; see Figure 1-3) and sampled them six times over a period of eight months. Samples were analyzed for arsenic, cadmium, chromium, lead, mercury, and selenium. Cadmium was the only constituent detected above the MTCA cleanup levels. In 1982, Ecology agreed that further sampling of the ground water was not necessary.

The wells were sampled again in 1988 for arsenic, cadmium, lead, mercury, and selenium. No analytes were detected above MTCA cleanup levels.

Conclusions: Farallon Consulting concluded that there was no evidence of ground water contamination from the fume material and negligible potential for adverse effects to aquatic organisms from this material. They further concluded that, since operations at the site were similar through the 1980s and 1990s, fume waste material generated during those years would be of similar composition to earlier sample results (Farallon Consulting 2008).

1.2.5.13 START Preliminary Assessment

A Preliminary Assessment (PA) was prepared by E & E in 2012 for the EPA. The PA was conducted in response to a citizen's petition (E & E 2012).

The PA indicated that the primary potential sources of contamination at the site are the fume ponds and fume storage area, which are unlined and have the potential to leach metals or other fume components to the ground water. The primary contaminants of concern that were associated with these sources were determined to be cadmium and chromium, though arsenic was also detected in these sources. The PA indicted that the waste disposal area had not been sampled, and potential contaminants associated with it were not known.

Though a number of wells in Rock Island, Washington, contained elevated concentrations of arsenic, the PA concluded that the fume pond and plant were not likely sources for this contamination based on earlier sampling. However, independent verification of fume pond and on-site ground water sampling results had not been conducted, and documentation of quality assurance for these data was not available.



The PA also indicated that an additional potential source of high arsenic concentrations in ground water in the Rock Island area was historical lead arsenate pesticide use; and that arsenic from lead arsenate pesticide application or storage areas may remain in area soils.

1.2.6 Previous Area Investigations

The START reviewed ground water quality and sampling information for the Rock Island area. Ground water investigations are summarized below:

1.2.6.1 Washington State University Water Quality Report

A preliminary water quality report was commissioned by the Chelan County PUD to determine background data and to predict potential impacts to ground water quality that could occur following the proposed raising of Rock Island Dam.

Ground water samples were collected in August 1973 through November 1974, and analyzed for nutrient and coliform contamination. In addition, static water levels were measured. The report indicated that many wells were not properly sealed and, therefore, were potential pathways for surface contamination to reach the ground water. Analysis for metals was not conducted during this study (WSU 1975).

A follow-up report by WSU included data collected during 1978 and 1979 after the water level in the Columbia River was raised by the construction of the addition to the Rock Island Dam. For this phase of the study, samples were collected from 25 ground water locations throughout the city of Rock Island (see Figure 1-4) and four surface water locations on the Columbia River (two upstream of Rock Island, and two downstream of Rock Island; see Figure 1-5). The samples were analyzed for certain metals (along with nutrients and coliform), including arsenic, bromine, cadmium, chromium, copper, iron, lead, manganese, selenium, silver, and zinc.

Arsenic values exceeded 1978 EPA Safe Drinking Water Act MCL 50 micrograms per liter [μ g/L]) in one well, Well 85, which was reported to have an arsenic concentration of 86 μ g/L when sampled in September 1978. Well 85 was sampled again the following spring. At that time, arsenic concentrations were reported as 43 μ g/L; which was below the EPA MCL of 50 μ g/L at that time. Other metals detected in ground water included chromium, copper, iron, manganese, and zinc; none of these metals were detected at concentrations above MCLs.

Surface water samples from the Columbia River indicated that all metals analytical results were below detectable levels, except manganese and iron which were within Ecology's Class A Water Quality Criteria.

Ground water flow during the monitoring period was generally to the southeast; however, ground water direction varied seasonally. During the irrigation season (about April to September), cones of depression on the ground water table



associated with wells supplying local orchards caused local variation in ground water flow direction (WSU 1979).

1.6.1.2 Washington Department of Social and Health Services Water Quality Report for Drinking Water at Rock Island, 1989

A letter, dated April 6, 1989, from the Washington State Department of Social and Health Services (DSHS) to Washington State Representative, included an attached water quality report and indicated that follow-up sampling had been conducted in response to high levels of metals reported in Rock Island wells during earlier sampling.

DSHS indicated that all of the re-samples and results had not confirmed the earlier results which were reported from an uncertified laboratory. The report concluded that there were no health concerns with the drinking water at that time. Although one well showed mercury levels just above the MCL, this was most likely due to the type of sample container used for collection. A follow-up sample from this well indicated mercury levels below the detection limit (DSHS 1989).

1.6.1.3 Water Quality at Rock Island, December 1990

In a memo dated December 31, 1990, entitled "Water Quality at Rock Island," Ecology summarized the water quality history of the area in order to achieve a basis for coordination of objectives between programs (Water Quality, Financial Assistance, and Toxics Cleanup). This summary is provided below:

- In 1973, a WSU water quality study was commissioned by the Chelan County PUD to predict ground water quality impacts which would occur by the proposed raising of the Rock Island Dam. The report determined that arsenic and selenium values exceeding the ground water standards set by EPA could be found in wells. Various rounds of follow-up sampling failed to confirm earlier results;
- In 1980, water samples were collected by Ecology from the effluent lagoons at the Rock Island Silicon Plant and analyzed for arsenic (as described in Section 2.5.1). Samples from the fume ponds showed high levels of arsenic;
- In 1980, two soil samples (i.e., one surface soil and one at 1 foot bgs) were collected from land in use as an orchard and from land not in use as an orchard. All four of the soil samples showed very high levels of arsenic and selenium. Results from these four samples indicated the following:
 - o Non-orchard soil:
 - Surface 9.3 milligrams per kilogram (mg/kg) arsenic, 3.4 mg/kg selenium, and
 - 1.0 foot bgs 20.0 mg/kg arsenic, 5.1 mg/kg selenium,
 - o Orchard soil:
 - Surface 30.0 mg/kg arsenic, 4.3 mg/kg selenium, and
 - 1.0 foot bgs 42.0 mg/kg arsenic, 6.0 mg/kg selenium;



- In 1980, Ecology sampled water in the fume ponds. The results of these samples indicated high levels of arsenic; however, these results were not confirmed in the 1988 site investigation (Ecology 1990); and
- In 1982, at the request of Ecology, Hanna Mining installed two monitoring wells adjacent to a fume settling pond at the plant to determine if the ponds were impacting ground water. Results of ground water monitoring indicated that fume pond materials were not leaching to ground water. Ground water monitoring was conducted without a written procedure, and well construction details were unknown. Ground water monitoring results did show a seasonal variation and were within EPA drinking water standards.

1.6.1.4 Ground Water Production Evaluation, City of Rock Island, Washington, September 2007

A hydrogeologic evaluation was performed by GeoEngineers in support of a water system improvement project for the City of Rock Island. The City of Rock Island water system Well No. 3 had exceedances of water quality standards for arsenic, and for this reason the city intended to install a new well to replace Well No. 3. This report consists of a review of background hydrogeologic and ground water quality information, and a hydrogeologic reconnaissance. As part of the hydrogeologic evaluation, water samples were collected from private wells. Figure 1-6 shows the results of analysis for arsenic in these wells (GeoEngineers 2007).

Conclusions and recommendations included the following:

- The glaciofluvial aquifer underlying the city is relatively shallow and primarily overlain by permeable sand and gravel deposits with no continuous low- permeability aquitard within the unsaturated zone. Because of this, the aquifer is highly susceptible to contamination introduced either on the ground surface or within the unsaturated zone. Development of a Wellhead Protection Plan was recommended;
- Elevated nitrate concentrations in Well No. 2 were suspected to be related to discharges from septic tanks located upgradient of the well, and possibly the leaching of nitrogen-bearing fertilizers in upgradient agricultural areas;
- Historic use of lead arsenate pesticides in orchards situated upgradient (northwest) of Well No. 3 was believed to be the most likely source of arsenic in that well;
- Ground water contamination levels in the Rock Island area (arsenic and nitrate) did not appear to be evenly distributed across the aquifer, and there was a potential for finding a source of ground water with favorable arsenic and nitrate concentrations within the city boundaries;
- Most arsenic exceedances in this region occur within and adjacent to agricultural areas with historic orchard use. Widespread arsenic and lead soil



contamination in these areas is generally attributed to application of lead arsenate pesticides, which were primarily used to control chewing insects in apple and pear orchards. Lead arsenate pesticide use was widespread in Washington until 1948, when dichlorodiphenyltrichloroethane (DDT) was introduced. Arsenic bonds strongly to soil particles and can persist in the environment for decades; and

Permeable, relatively alkaline soil conditions are conducive to the mobilization of arsenic to ground water. GeoEngineers believed that the historic use of lead arsenate pesticides in orchards situated upgradient (northwest) of Well No. 3 was the most likely source of arsenic in that well.

1.6.1.5 Phase I Hydrogeologic Evaluation, Proposed Golf Course Well Site, City of Rock Island, Washington, February 2009

In 2009, GeoEngineers evaluated the feasibility of installing a new ground water production well at the golf course in Rock Island, Washington. This evaluation was conducted for the City of Rock Island, which was evaluating the site for a proposed drinking water well. GeoEngineers conducted an environmental review, ground water monitoring well installation, and ground water sampling. Arsenic levels in the monitoring wells were below MCLs. GeoEngineers concluded that the golf course site was suitable for an additional well (GeoEngineers 2009).

1.6.1.6 Phase II Hydrogeologic Evaluation, Golf Course Well Site, City of Rock Island, Washington, January 2010

GeoEngineers observed golf course municipal well drilling, installation, and testing. A total of eight ground water samples were collected from borings at the potential well site for laboratory analysis of nitrate and arsenic. Nitrate and arsenic concentrations in these samples were well below EPA drinking water standard concentrations (GeoEngineers 2010).

1.6.1.7 EPA Removal Program Sampling

On July 7, 2011, EPA sampled soil, sediment, and ground water in the area of Rock Island, Washington (see Figure 1-7). This action was in response to an EPA Public Petition from a local resident. A removal assessment was conducted to determine whether Rock Island residents were being exposed to potentially contaminated ground water and to identify the source of contamination, if possible (TechLaw Inc. 2012).

Soil and sediment samples were collected from the following locations:

- Two background soil samples were collected from Kirby Billingsley Hydro Park (BG-1). One sample was collected from 0 to 6 inches bgs and one sample was collected from 3.0 to 3.5 feet bgs.
- Three soil samples, including a duplicate sample were collected on residential property (SS-1/SS-2). Of these, one sample and a field duplicate were collected from 0 to 6 inches bgs and one sample was collected from 3.0 to 3.5 feet bgs.



- One soil sample was collected east of the former silicon plant property south of State Highway 28, from 0 to 6 inches bgs (SS-3).
- One sediment sample was collected at a freshwater pond east of the silicon plant property and south of State Highway 28, from 0 to 6 inches in depth (SD-1).

Analytical results indicated that soil at the residential property tested above MTCA Method A cleanup levels and EPA residential soil risk-based protection of ground water screening levels for arsenic, lead, 1,1-dichloro-2,2-bis(p-chlorophenyl) ethylene (DDE), and DDT. Soil sample SS-3 collected south of State Highway 28 slightly exceeded the arsenic MTCA Method A cleanup levels. Background soil samples also exceeded MTCA Method A cleanup levels for arsenic and lead (TechLaw Inc. 2012). Because this area has historically been used for orchards, it is possible that a former orchard may have been located at the site currently occupied by the Kirby Billingsley Hydro Park. Therefore, the samples results from the park were not used as background concentrations for comparison purposes (TechLaw Inc. 2012).

Ground water samples were collected from three residential wells (GW-1/GW-2, GW-3, and GW-4) within Rock Island (see Figure 1-7). GW-1/GW-2 is located approximately 600 feet north of State Highway 28. GW-3 is approximately 0.5 mile west of GW-1, and GW-4 is approximately 0.7 mile north of GW-1. Two ground water samples, including a duplicate sample (GW-2), were collected from location GW-1 (TechLaw Inc. 2012).

Analytical results indicated that concentrations of arsenic in ground water at GW-1/GW-2 sample location were 117 μ g/L and 114 μ g/L, more than eleven times higher than the EPA MCL. The concentration of arsenic in the ground water sample from GW-3 was 18.9 μ g/L, almost twice the MCL. The concentration of arsenic in the ground water sample from GW-4 was 2.6 μ g/L, below the MCL of 10 μ g/L. No other metals in the ground water samples exceeded MCLs (TechLaw Inc. 2012).

The removal assessment report recommended further investigation to determine the extent, magnitude, and source of the metals contamination to residential soil and ground water (TechLaw Inc. 2012).

1.3 Migration/Exposure Pathways and Targets

This subsection discusses the ground water migration, and soil exposure pathways and potential targets within the site's range of influence (see Figures 1-8 and 1-9). The surface water migration pathway and air migration pathway have not been included for samplings as a component of this SI due to a lack of targets (i.e., receptors) in those pathways as per the EPA TM.



1.3.1 Ground Water Migration Pathway

The target distance limit (TDL) for the ground water migration pathway is a 4-mile radius that extends from the sources at the site. Figure 1-8 depicts the ground water 4-mile TDL.

1.3.1.1 Geologic Setting

The site is located within the Columbia Basin, a physiographic province underlain by Miocene Columbia River Basalt Group rocks (GeoEngineers 2007).

The site is located at the southeastern edge of the city of Rock Island. The city of Rock Island is located in a "tea cup" shaped valley surrounded by bluffs. There are seven lakes situated in a chain-like pattern paralleling the surrounding bluffs, suggesting that they are located along the path of an earlier meander of the Columbia River (GeoEngineers 2007).

Surficial geology within the Columbia River valley near and within the city of Rock Island generally consist of Quaternary glaciofluvial and mass wasting deposits, with minor alluvial sediments. Glaciofluvial deposits generally consist of unsorted mixtures of silt, sand, gravel, cobbles, and boulders deposited during Pleistocene catastrophic flooding events. Mass wasting deposits generally consist of landslide material, talus, and colluvium composed of unsorted sediments and angular basalt fragments. Alluvial deposits generally consist of silt, sand, and gravel deposited by the Columbia River (GeoEngineers 2007).

The site is underlain by alluvial deposits and glaciofluvial deposits (USGS 1982). Well logs at the site indicate sand and gravel (Ecology 2011a).

1.3.1.2 Aguifer System

The city of Rock Island is underlain by a glaciofluvial aquifer consisting of sand and gravel with relatively high hydraulic conductivity and transmissivity. The aquifer is unconfined, and saturated aquifer thickness varies from less than 10 feet along boundaries with bedrock and mass wasting deposits to more than 180 feet within the interior of the city (GeoEngineers 2007). The Washington State University College of Engineering Research Division (WSU 1979) monitored ground water elevations in the Rock Island area during the period from August 1973 through November 1974 (see Section 2.5.1). This study determined that ground water flow was generally to the southeast; however, ground water direction varied seasonally. During the irrigation season (about April to September) cones of depression on the ground water table associated with wells supplying local orchards caused local variation in ground water flow direction (GeoEngineers 2007).

There are two wells on site (Well No. 2 and Well No. 3), both 105 feet deep. Well No. 2 is screened from 74 to 105 feet bgs, and Well No. 3 is screened from 65 to 105 feet bgs.



Well logs for monitoring wells at the site indicate that ground water was 28 feet bgs, when recorded in February (Ecology 2011a).

Ground water sampling results from wells in the Rock Island area indicated the presence of arsenic above MCLs in five residential wells and one city well (GeoEngineers 2007 and TechLaw, Inc. 2012).

1.3.1.3 Drinking Water Targets

Ground water is used to supply domestic and municipal wells within the 4-mile TDL. Drinking water populations by distance ring are provided in Table 1-3.

Domestic drinking water well logs within the TDL are maintained by Ecology. A search of Ecology's well logs revealed domestic wells within the 4-mile TDL (Ecology 2011a). Based on the most current census data, the average household size in Douglas County is 2.5 people (USDOC 2001). Approximately 580 people (232 wells times 2.5 people per household) utilize domestic drinking water wells within the TDL.

The City of Rock Island's water system consists of a single pressure zone, four wells (two wells actively used for drinking water supply, one for irrigation, and one inactive well), and two reservoirs. The water system serves approximately 298 residential and commercial connections. The two active wells are located within 0.25 to 0.5 mile of the site. The total water service area population is about 1,043 people (City of Rock Island 2007). The pumping capacity of the wells could not be obtained. For the purposes of this report, it is assumed that no well contributes more than 40% of the total pumping capacity. The site is not located within a wellhead protection area.

Ground water is used for irrigation of food crops of five or more acres within 0.5 mile of the site (Ecology 2011b).

1.3.2 Soil Exposure Pathway

The soil exposure pathway is evaluated based on the threat to resident and nearby populations from soil contamination within the first 2 feet of the surface.

1.3.2.1 Site Setting and Exposed Sources

Soil beneath the fume ponds, fume storage area, and waste disposal area are potentially contaminated and cover approximately two-thirds of the site (approximately 193,600 square yards). Potential contaminants are cadmium and chromium (Farallon Consulting 2008). The extent of contaminated soil near the former QC lab drywell and transformer areas is not known.

1.3.2.2 Targets

There are two workers at Specialty Chemical Products on site, but there are no other human receptors residing or attending school/daycare within an area of observed contamination. No resources such as commercial agriculture, silviculture, livestock production, or commercial livestock grazing occur within



an area of exposed contaminated soil/material. No terrestrial sensitive environments are documented within an area of contamination at the site.

The site is not fenced and is accessible to the public. The nearest residence is located across State Highway 28, approximately 500 feet north of the site. Rock Island Elementary school is located approximately 0.9 mile northwest of the site. There are 225 students enrolled at the school and 15 staff members (Eastmont 206 School District 2011).

1.4 Areas of Potential Contamination (Sources and Targets)

Sampling under the Rock Island Silicon Plant SI will be conducted at areas considered potential contamination sources and at areas that may have been contaminated through the migration of Comprehensive Environmental Response, Compensation, and Liability Act—regulated hazardous substances from sources on site. Based on a review of background information, the following areas or features have been identified for inspection under the Rock Island Silicon Plant (Former) SI.

1.4.1 Sources

The sources at the site include:

Fume Pond Settling System

The fume pond settling system comprises eight former settling ponds located in the central portion of the facility. The volume of fume in the ponds was calculated to be 43,533 cubic yards in 2003, after silicon metal manufacturing activities had ceased (Specialty Chemical Products 2003). The closest pond to the Columbia River is approximately 30 feet north of the river (see Figure 1-2). Samples from the fume ponds indicate the presence of chromium and cadmium at concentrations above MTCA Method A Cleanup Levels. Antimony, arsenic, copper, lead, mercury, nickel, silver, and zinc also were detected (Farallon Consulting 2008).

Fume Storage Area

In addition to the ponds, there is a fume storage area which consists of fume stockpiles that were formed by periodic excavation of fume material from the ponds. The volume of fume in the storage area was calculated to be 133,057 cubic yards in 2003 (Specialty Chemical Products 2003). Potential hazardous substances associated with the storage piles are those found in the fume, which are chromium and cadmium (Farallon Consulting 2008).

Waste Disposal Area

A waste disposal area is present on site. The disposal area is approximately 30,000 square feet and had been used to dispose of various materials including floor sweepings, raw materials unsuitable for processing, fiberglass bags, and damaged carbon electrodes (EEC 1992). This area has not been sampled;



therefore, hazardous substances that may be associated with this area are unknown.

1.4.2 Targets

Residential Soil and Ground Water

To determine potential impacts to Rock Island area drinking water wells and residential soils, samples will be collected from two residences located northwest of the site. Potential contaminants of concern are TAL metals.

1.5 Sampling Process Design

During the Rock Island Silicon Plant SI, samples will be collected from locations or features considered potential contamination sources, from selected potential hazardous substance migration pathways, and from potential targets in those pathways. The locations or features to be sampled have been determined based on information derived from a review of background information and interviews with site representatives and with regulatory agencies. Table 1-4 provides information regarding the sampling design and whether the measurement is considered critical or noncritical

At the time of sampling, site—specific conditions (e.g., topography or visual evidence of contamination) will be evaluated and incorporated, when applicable, into the placement of sampling locations. Other conditions potentially contributing to deviations from the projected sampling locations include new observations or information obtained in the field that warrant an altered sampling approach, difficulty in reaching a desired soil sampling depth caused by high density soil, obstructions, or limited access to a sampling location. Significant deviations from the planned sampling locations or number of samples to be collected will be discussed with the EPA Task Monitor (TM) before implementation and will be documented on a Sample Plan Alteration Form (SPAF) (see Appendix A). Every attempt will be made to collect representative samples with the equipment being used.

1.5.1 Sample Locations

Sample locations will be selected to achieve the objectives discussed in Section 1.3.1. Figure 1-10 depicts proposed sample locations.

1.5.1.1 Potential Source Locations

The following samples will be collected at source locations:

- Subsurface Soil Samples Several boreholes will be advanced to ground water, which is approximately 25 to 44 feet bgs. Hollow-stem auger drilling techniques will be utilized to advance 2-inch boreholes to ground water. The boreholes will be placed in the following locations to address the potential source locations on site, for a total of 9 boreholes and a total of 36 samples as described below:
 - o The fume pond settling system comprises eight former settling ponds lo-

cated in the central portion of the facility. The fume ponds are estimated to range in depth from approximately 1.5 to 11 feet. One borehole will be placed in each of the former settling ponds numbered 1-7. Former settling pond No. 8 is presumed to be similar in composition to former settling pond No. 7, since they were in use at the same time (EDR 2011); therefore the sample collected from settling pond No. 7 will be assumed to be representative of pond No. 8 as well. Up to four soil samples will be collected from each borehole at the following intervals: 2.5 to 4 feet bgs, 6.5 to 8 feet bgs, 8.5 to 11 feet bgs (or to the bottom of fume, whichever is less), and one from a 1.5-foot interval beginning at the water table.

- One borehole will be placed in the fume storage area. Up to four soil samples will be collected from this borehole at the following intervals: 2.5 to 4 feet bgs, 6.5 to 8 feet bgs, 9.5 to 12 feet bgs (or to the bottom of fume, whichever is less), and one from a 1.5-foot interval beginning at the water table.
- One borehole will be placed in the waste disposal area. Up to four soil samples will be collected from this borehole at the following intervals:
 2.5 to 4 feet bgs, 6.5 to 8 feet bgs, 9.5 to 12 feet bgs, and one from a 1.5-foot interval beginning at the water table.
- Ground Water Samples: One ground water sample will be collected from each of the nine boreholes described above. Two additional boreholes will be advanced on the site: one between the fume ponds and the Columbia River and one on the northern side of the site between the site and the residential areas to the northeast. A ground water sample will be collected from each of these boreholes. In all boreholes, temporary well screens will be placed to straddle the water table and to extend at least 2 feet into the saturated zone. Two additional ground water samples will be collected from existing water production wells on site, provided these wells are accessible for sampling.

1.5.1.2 Potential Target Locations

Residential Soil Samples: Soil samples will be collected from up to four locations at each of two residential properties. Surface soil samples will be collected from 0 to 6 inches bgs, and subsurface soil samples will be collected from 2 to 4 feet bgs, for a total of up to 16 soil samples. At each residence, at least one of the soil sample locations will be adjacent to the water well located at the residence. The location of the two residential properties is depicted in Figure XX.

Residential Ground Water Samples: One ground water sample will be collected from the water wells located at two residential properties, for a total of two ground water samples. The sampling locations were selected based on previous ground water sampling results.

1.5.1.3 Background Locations

Up to seven background samples will be collected. Background samples will be collected from one off-site location expected to be uninfluenced by site activities.



Four subsurface soil samples will be collected from one borehole at 2.5 to 4 foot bgs, 6.5 to 8-foot bgs, 9.5 to 12-foot bgs; and from a 1.5-foot interval beginning at the water table.. One background surface soil sample will be collected. One ground water sample will be collected from the background borehole; and one background domestic well sample will be collected.

1.5.1.4 Quality Assurance/Quality Control Samples

- Rinsate Blanks: Rinsate blanks will be collected from the drill rig cutting shoe, non-dedicated ground water pump, and the hand auger at a rate of one per 20 field samples. Approximately three rinsate samples will be collected from the drill rig cutting shoe, one from the non-dedicated pump, and one from the hand auger.
- Investigation-Derived Waste (IDW): One sample from each drum of IDW containing purge water and/or decontamination water will be collected for waste characterization and disposal. Analytical results from subsurface soil samples will be used for waste characterization and disposal of IDW drums containing soil cuttings. An estimated 10 drums of IDW (three containing purge/decontamination water and seven containing soil cuttings) will be generated utilizing a hallow stem auger drilling method.

1.5.2 Analytical Protocol

The following analyses will be applied:

- Soil Samples: All soil samples will be submitted for off-site fixed lab analysis of TAL metals including mercury.
- Ground Water: During purging of domestic wells and on-site temporary and production wells, water quality parameters for pH, conductivity, temperature, dissolved oxygen, and oxidation reduction potential will be monitored using a water quality meter with a flow-through cell. Readings will be recorded in a field logbook and will be used to determine when water conditions have stabilized. Water from all wells will be analyzed at a fixed laboratory for select anions (bromide, chloride, bicarbonate, sulfate, and nitrate) and alkalinity. Nitrate levels will be checked following purging using nitrate test strips having the ability to read nitrate at 2 parts per million (ppm) or lower. Water samples for fixed laboratory analysis of nitrate will be collected from locations containing nitrate above 2 ppm. Locations exhibiting nitrate concentrations below 2 ppm will not be further analyzed for nitrate. All ground water samples will be submitted for off-site fixed lab analysis of TAL metals including mercury. Water from on-site temporary wells will be filtered in the field prior to collecting sample aliquots as described in Section 1.5.3 below.

Table 1-5 identifies both environmental and quality control (QC) samples to be collected and analyzed.



1.5.3 Sampling Methodologies

The START-3 Project Manager (PM) and EPA TM will be responsible for ensuring that appropriate sample collection procedures are followed and will take appropriate actions to correct the deficiencies. All samples collected will be maintained under chain-of-custody and will be stored and shipped in iced coolers.

- **Surface Soil Sampling.** Surface soil (0 to 6 inches bgs) will be collected using dedicated plastic scoops. Collected material will be placed in a dedicated plastic bowl, thoroughly homogenized, and placed into a prelabeled container.
- Subsurface Soil Sampling. Subsurface soil samples will be collected from on-site boreholes and from offsite residences. Subsurface soil sampling will be conducted as follows:
 - On-site Boreholes: Boreholes will be drilled using a subcontracted hollow-stem auger drill rig. Boreholes will be 2-inches in diameter. Subsurface soil samples will be collected from the boreholes using a decontaminated split-spoon sampler. Sampling intervals will be as discussed in Section 1.5.1. The samples will be collected in dedicated Teflon-lined sleeves. The collected material will be placed in a dedicated plastic bowl, thoroughly homogenized when applicable, and placed into a pre-labeled sample container.
 - Off-site Residences: Subsurface soil samples will be collected from 2 to 4 feet bgs using a decontaminated hand auger. The collected material will be placed in a dedicated plastic bowl, thoroughly homogenized when applicable, and placed into a pre-labeled sample container.
- Borehole Ground Water Sampling. Once ground water is reached, a dedicated temporary 5-foot 2" PVC well screen will be installed in the boring. The well screen will penetrate 2 feet into the saturated zone. The well will be of sufficient diameter to facilitate the collection of ground water with a low flow, variable speed sample pump capable of pumping ground water from 40feet bgs to the ground surface. The pump will be adjusted to ensure a flow rate between 100 and 500 milliliters per minute to allow low flow purging and sampling. Three volumes of water will be purged from the boreholes prior to sampling. During purging, water quality parameters (pH, conductivity, temperature, dissolved oxygen, and oxidation reduction potential) will be monitored and recorded in a field logbook. Further, drawdown on the water table will be monitored at 5 minute intervals with a water level indicator. Drawdown will not be allowed to exceed 0.3 foot during purging and sampling by adjusting the pump flow rate. Ground water samples collected from boreholes will be filtered in the field using a 45-micron in-line filter; then placed into sample containers and preserved as necessary.
- Well Sampling. Drinking water and on-site well samples will be collected in accordance with the procedures identified in Groundwater Well Sampling



SOP included in Appendix C. During purging, water quality parameters (pH, conductivity, temperature, dissolved oxygen, and oxidation reduction potential) will be monitored and recorded in a field logbook. Once water conditions have stabilized (i.e., three successive readings taken at 5 minute intervals meet the tolerances stated in the Groundwater Well Sampling SOP section 6.2.6), water samples will be collected. Domestic and on-site production well samples will not be filtered. These samples will be pumped directly into pre-labeled sample containers and preserved as required upon sample collection completion.

1.5.4 Standard Operating Procedures

The START-3 will utilize the following Standard Operating Procedures (SOPs; see Appendix C) while performing field activities:

- Borehole Installation and Subsurface Soil Sampling Methods,
- Field Activity Logbooks,
- Geologic Logging,
- Groundwater Well Sampling,
- Sample Equipment Decontamination,
- Sample Packaging and Shipping,
- Surface and Shallow Subsurface Soil Sampling, and
- Water Level Measurements.

1.5.5 Sampling Equipment Decontamination

To the greatest extent possible, disposable and/or dedicated personal protective and sampling equipment will be used to avoid cross-contamination. When required, decontamination will be conducted in a central location, upwind, and away from suspected contaminant sources. The following procedures are to be used for all nondedicated sampling equipment used to collect routine samples undergoing trace organic or inorganic constituent analyses:

- 1. Clean with tap water and nonphosphate detergent, using a brush if necessary to remove particulate matter and surface films. (Equipment may be steam cleaned [soap and high pressure hot water] as an alternative to brushing. Sampling equipment that is steam cleaned should be placed on racks or saw horses at least two feet above the floor of the decontamination pad. Polyvinyl chloride (PVC) or plastic items should not be steam cleaned.)
- 2. Rinse thoroughly with tap water.
- 3. Rinse thoroughly with de-ionized water.
- 4. Air dry the equipment completely.
- 5. Rinse again with distilled/de-ionized water.

Remove the equipment from the decontamination area. If the equipment is not to be immediately re-used, it should be covered with plastic sheeting to prevent re-



contamination. The area where the equipment is kept prior to re-use must be free of contaminants.

1.5.6 Global Positioning System

Global Positioning System (GPS) units with data loggers will be used to identify the location coordinates of every sample collected, as well as to delineate the boundaries of the potential source areas. GPS coordinates will be provided in the final Rock Island Silicon Plant SI report as an appendix. If real-time coordinates cannot be obtained for the site, the START-3 will obtain differential correction data from a local source prior to the start of the survey in order to improve the survey resolution.

1.5.7 Investigation-Derived Waste

The START-3 field team members will make every effort to minimize the generation of investigation-derived waste (IDW) throughout the field event. Attempts will be made to evaporate waste water from decontamination operations on-site. Any waste water that cannot be evaporated will be contained in 55-gallon drums. Additionally, borehole purge water will be contained in 55-gallon drums. All IDW drums will be labeled, and disposed of at an approved facility based on analytical results from matrix and profile samples. It is expected that three 55-gallon drums will be required to contain decontamination/purge water. An additional seven 55-gallon drums will be used to contain soil cuttings generated during drilling activities.

Disposable personal protective clothing and sampling equipment generated during field activities will be rendered unusable by tearing (when appropriate), bagged in opaque plastic garbage bags, and disposed of at the local municipal landfill. Where possible, dedicated sample material (stainless steel bowls and spoons), cardboard, and plastics will be segregated and recycled.

1.6 Coordination with Federal, State, and Local Authorities

The START-3 will keep the EPA TM informed of field event progress and issues that may affect the schedule or outcome of the SI, will discuss problems encountered, will inform the EPA of any unusual contact with the public or the media, and will obtain guidance from the EPA regarding project activities when required. Additionally, the START-3 will notify the EPA Regional Sample Control Coordinator (RSCC) of any changes to the sampling schedule for Manchester Environmental Laboratory (MEL) and/or Contract Laboratory Program (CLP) analyses and will provide shipping information on every sample shipment within 24 hours of shipment or before noon on Friday for Saturday delivery. All samples will be shipped to the laboratory within 24 to 48 hours of sample collection. Further, each SCRIBE CLP XML COC file will be uploaded to the SMO portal on each day of sample shipment.

Before initiation of the SI field activities, the START-3 or EPA TM will provide notification to the property owners/operators, and local residents.



1.7 Logistics

The Rock Island Silicon Plant (Former) and Rock Island area residential properties are accessible by car. A rental vehicle will be needed to transport field supplies from the warehouse to the site. Property access has been obtained.

Sample aliquots collected for fixed laboratory analysis will be delivered to the EPA Region 10 laboratory or an alternative laboratory as directed by the EPA. All fixed-laboratory samples will be shipped daily or every other day or at the end of the field work by commercial airlines for express delivery. Sample control and shipping are discussed in subsection 3.2.

1.8 Schedule

The schedule for implementing the Rock Island Silicon Plant (Former) SI is intended to be used as a guide. Adjustments to the implementation dates and the estimated project duration may be necessary to account for variable unforeseen or unavoidable conditions that the field team may encounter. Examples include inclement weather, difficulties in accessing a sampling site, unforeseen site conditions, or additional time needed to complete a task. Significant schedule changes that arise in the field will be discussed with the TM at the earliest possible opportunity.

The START-3 is targeting October 29, 2012, as the earliest period to conduct the SI field work, which is estimated to take six days, including travel time to and from the site. This period comprises one day of mobilization, one day of demobilization, and four days to complete field activities. Work will be conducted during daylight hours only. The proposed schedule of project work is presented in Table 1-6.



2

Project Management

2.1 Project Task Organization

This subsection outlines the individuals directly involved with the SI and their specific responsibilities. Communication lines are shown in the Project Organization Chart (see Figure 2-1).

2.1.1 EPA Region 10 Task Monitor

The EPA TM is the decision maker and overall coordinator for the project. The TM reviews and approves the site-specific SQAP and subsequent revisions in terms of project scope, objectives, and schedules. The TM ensures site-specific SQAP implementation and serves as the primary point of contact for project-related problem resolution and has approving authority for the project.

2.1.2 EPA Region 10 Regional Quality Assurance Manager

The EPA Regional Quality Assurance Manager (QAM) or designee reviews and approves the site-specific SQAP and revisions in terms of QA aspects. The QAM or designee may conduct assessments of field activities.

2.1.3 EPA Region 10 Regional Sample Control Coordinator

The EPA Regional Sample Control Coordinator (RSCC) coordinates sample analyses performed through the EPA CLP, the EPA Region 10 MEL, or both and provides sample identification numbers.

2.1.4 E & E START-3 Site Assessment Project Leader

The E & E START-3 Project Leader (PL) provides for the overall coordination of all START-3 Site Assessment projects, ensuring that the projects are technically consistent, accurate, and conform to the overall goals of the EPA Site Assessment Program.

The Site Assessment PL is the EPA's point of contact for all Site Assessment program questions and the alternative point of contact for all site assessment projects.

2.1.5 E & E START-3 Project Manager

The E & E START-3 PM provides overall coordination of field work and provides oversight during the preparation of the site-specific SQAP. The PM implements the final approved version of the site-specific SQAP, records any



deviations from the plan, and acts as the primary contact point for the EPA TM. The PM receives CLP/EPA Region 10 laboratory information from the RSCC, acts as the START's primary point of contact for technical problems, and is responsible for the execution of decisions and courses of action deemed appropriate by the TM. In the absence of the START-3 PM, a START-3 site manager will assume the PM's responsibilities.

2.1.6 E & E START-3 Quality Assurance Officer

The E & E Quality Assurance Officer (QAO) reviews and approves the site-specific SQAP, conducts in-house audits of field operations, and is responsible for auditing and reviewing the field activities and final deliverables and proposing corrective action for nonconformities, if necessary.

2.1.7 E & E START-3 Analytical Coordinator

The E & E START-3 Analytical Coordinator (AC) receives the CLP/EPA Region 10 laboratory information from the EPA RSCC. The AC also receives validated data from the EPA chemists.

2.1.8 EPA Project Officer and E & E START-3 Program Manager

The EPA Project Officer (PO) is responsible for coordinating resources requested by the TM for this project and for the overall execution of the START-3 program.

The START-3 Program Manager is responsible for the overall management of E & E resources for the START-3 contract.

2.2 Quality Objectives and Criteria for Measurement Data

The project data quality objectives (DQOs) are to provide valid data of known and documented quality to characterize sources, determine off-site migration of contaminants, determine whether the site is eligible for placement on the NPL, and document any threats or potential threats that the site poses to public health or the environment. The DQO process applied to this project follows that described in the document *Guidance for the Data Quality Objectives Process* (EPA 2006). See Section 3.6 for a detailed measurement criteria discussion.

2.2.1 Data Quality Objective Data Categories

All samples collected under this SQAP will be analyzed using definitive analytical methods. All definitive analytical methods employed for this project will be methods that have been approved by the EPA. The data generated under this project will comply with the requirements for this data category as defined in *Data Quality Objectives Process for Superfund Interim Final Guidance* (EPA 1993).

2.2.2 Data Quality Indicators

The goals of data quality indicators (DQIs) representativeness, comparability, completeness, precision, and accuracy for this project were developed following guidelines presented in the EPA *Guidance for Quality Assurance Project Plans*, EPA QA/G-5 (EPA 2002).



The basis for assessing each of the elements of data quality is discussed in the following subsections. Subsection 3.6 presents the QA objectives for measurement of analytical data and QC guidelines for precision and accuracy. Other DQI goals are included in the individual SOPs in Appendix C and in the Laboratory SOW.

2.2.2.1 Representativeness

Representativeness is a measure of the degree to which data accurately and precisely represent a population, including a sampling point, a process condition, or an environmental condition. Representativeness is the qualitative term that should be evaluated to determine that measurements are made, and physical samples collected, at locations and in a manner resulting in characterizing a matrix or media. Subsequently, representativeness is used to ensure that a sampled population represents the target population and an aliquot represents a sampling unit. This SQAP will be implemented to establish representativeness for this project. Further, all sampling procedures detailed in the SQAP will be followed to ensure that the data are representative of the media sampled. The SQAP describes the sample location, sample collection, and handling techniques that will be used to avoid contamination or compromising of sample integrity and to ensure proper chain-of-custody of samples. Additionally, the sampling design presented in the SQAP will ensure a sufficient number of samples and level of confidence that analysis of these samples will detect any chemicals of concern present.

2.2.2.2 Comparability

Comparability is the qualitative term that expresses the measure of confidence that two data sets or batches can contribute to a common analysis and evaluation. Comparability with respect to laboratory analyses pertains to method type comparison, holding times, stability issues, and aspects of overall analytical quantitation. The following items are evaluated when assessing data comparability:

- Determining if two data sets or batches contain the same set of parameters;
- Determining if the units used for each data set are convertible to a common metric scale;
- Determining if similar analytical procedures and QA were used to collect data for both data sets;
- Determining if the analytical instruments used for both data sets have approximately similar detection levels; and
- Determining if samples within data sets were selected and collected in a similar manner.



To ensure comparability of data collected during this investigation to other data that may have been or may be collected for each property, standard collection and measurement techniques will be used.

2.2.2.3 Completeness

Completeness is calculated for the aggregation of data for each analyte measured for any particular sampling event or other defined set of samples. Completeness is calculated and reported for each method, matrix, and analyte combination. The number of valid results divided by the number of possible individual analyte results, expressed as a percentage, determines the completeness of the data set. For completeness requirements, valid results are all results not rejected through data validation. The requirement for completeness is 95% for aqueous samples and 90% for soil and sediment samples.

The following formula is used to calculate completeness:

% completeness = <u>number of valid results x 100</u> number of possible results

For any instances of samples that could not be analyzed for any reason (e.g., holding time violations in which re-sampling and analysis were not possible, samples spilled or broken), the numerator of this calculation becomes the number of valid results minus the number of possible results not reported. For this investigation, all samples are considered critical. Therefore, standard collection (as defined in the sampling SOPs in Appendix C) and measurement methods will be used to achieve the completeness goal.

2.2.2.4 Precision

Precision measures the reproducibility of measurements. It is strictly defined as the degree of mutual agreement among independent measurements as the result of repeated application of the same process under similar conditions. *Analytical* precision is the measurement of the variability associated with duplicate (two) or replicate (more than two) analyses. The laboratory control sample (LCS) determines the precision of the analytical method. If the recoveries of the analytes in the LCS are within established control limits, then precision is within limits. In this case, the comparison is not between a sample and a duplicate sample analyzed in the same batch. Rather, the comparison is between the sample and samples analyzed in previous batches.

Total precision is the measurement of the variability associated with the entire sampling and analysis process. It is determined by analysis of duplicate or replicate field samples and measures variability introduced by both the laboratory and field operations. Field duplicate samples and matrix duplicate spiked samples shall be analyzed to assess field and analytical precision, and the precision measurement is determined using the relative percent difference (RPD) between the duplicate sample results.



The following formula is used to calculate precision:

RPD =
$$(100) \times \underline{(S1 - S2)}$$

 $(S1 + S2)/2$

where:

S1 = original sample value

S2 = duplicate sample value

In general, precision less than or equal to 35% RPC will fulfill the DQOs.

2.2.2.5 Accuracy

Accuracy is a statistical measurement of correctness and includes components of random error (variability due to imprecision) and systemic error. It reflects the total error associated with a measurement. Bias is the systematic or persistent distortion of a measurement process that causes errors in one direction. MS, LCS, and other reference materials are used to determine bias. A measurement is accurate when the value reported does not differ from the true value or known concentration of the spike and standard. Analytical accuracy is measured by comparing the percent recovery of analytes spiked into an LCS or MS to a control limit. For pesticide, PCBs, VOCs, and SVOCs, system monitoring compound recoveries are also used to assess accuracy and method performance for each sample analyzed. Analysis of performance evaluation (PE) samples may also be used to provide additional information for assessing the accuracy of the analytical data being produced. In general, accuracy between 50% and 150% will fulfill the DQOs. Spike sample results below the QC limits may indicate a low bias while spike sample results above the QC limits may indicate a high bias.

2.3 Special Training Requirements/Certification

No special training requirements or certifications are required for this project except for the 40-hour Hazardous Waste Operations and Emergency Response class and annual refreshers. Health and safety procedures for E & E personnel are addressed in E & E's site-specific Health and Safety Plan. This document is maintained in E & E's Seattle office. Included in the plan are descriptions of anticipated chemical and physical hazards, required levels of protection, health and safety monitoring requirements and action levels, personal decontamination procedures, and emergency procedures.

2.4 Documentation and Records

This document is meant to be combined with information presented in E & E's (2010b) *Region 10 START-3 Quality Assurance Project Plan*. This information is covered by the SOPs provided in Appendix C, the supplemental forms provided in Appendix B

This document is meant to be combined with information presented in E & E's (2010b) *Region 10 START-3 Quality Assurance Project Plan*. This information is covered by the SOPs provided in Appendix C and the supplemental forms



provided in Appendix B. Standards contained in the SOPs, the START-3 QAPP, and the QMP will be used to ensure the validity of data generated by E & E for this project.

Following the completion of field work and the receipt of analytical data, a report summarizing project findings will be prepared. Project files, including work plans, reports, analytical data packages, correspondence, chain-of-custody documentation, logbooks, corrective action forms, referenced materials, and photographs will be provided to the EPA TM at the close of the project. A CD-ROM deliverable containing the final report will be provided as well.

E & E will assemble and fully document a digital data set that includes all project sampling, analysis, and observation data. These digital data will be made available in a Microsoft-Access format.

E & E will transfer this data set and documentation to the EPA or, if requested, to any other EPA contractor and shall ensure that any data transferred are received in an uncorrupted, comprehensible, and usable format. Specific data deliverable elements are presented below.

Data

A summary description of the tables, the sources of information, and other comments are provided below.

Field Information

The field information table contains all sample collection related information. A Microsoft Access application (Sample Information System [SIS]) will be used to input and store the data. The SIS provides the user with "smart" data input forms that will only allow for the entry of acceptable data field values. For each sampling event, the SIS will be updated to reflect the new samples collected. Once entered, the information will be checked and corrected where necessary. To the extent possible, sample information is entered into SCRIBE (EPA's data handling software program) prior to the field event. Remaining field information is entered after each sampling day as part of sample documentation. The field information table structure is presented below.

Field Name	Type	Size	Description	
Sample-Num	Character	10	Sample Number	
Station	Character	10	Station Identifier	
Date	Date	8	Sample Date	
Time	Numeric	4	Sample Time (24-Hour clock)	
Sampler	Character	25	Person Name	
Matrix	Character	6	Sample Matrix – (i.e., soil boring, ground water, sediment)	
Water Depth	Numeric	5.1	Depth of Water at Sediment Sample	
Description	Character	40	Sample Description	
Comments	Character	40	Comments	



Location

The location table contains sample location coordinate information. The sample locations will be determined using Trimble Pro-XR GPS units. E & E personnel have been trained and have utilized these units in similar projects. For each day or half-day in the field that GPS sample location data are to be collected, the GPS user will create a single file that contains the locations of each sample station. A unique station label will be entered for each sample location. This unique station identifier will be used to link the "Location" table with the "Field-Info" table. This information will be downloaded from the GPS unit and imported into the "Location" table of the Site Data Management System (SDMS). All locational data for this project will be stored in decimal degrees and will be referenced to the World Geodetic System 1984 horizontal datum. Differential corrections will be made real-time. The table structure is presented below.

Field Name	Туре	Size	Description
Station	Character	10	Station Identifier
X-Coord	Numeric	12.6	X-Coordinate, Decimal Degrees
Y-Coord	Numeric	12.6	Y-Coordinate, Decimal Degrees

Lab Analytical

The Lab Analytical table will hold all of the sample analysis results provided by each laboratory analyzing samples. The integrity of each data file received from the labs will be checked and verified. The validation chemist will perform a 50% or more check of only the positive results by comparing the hard copy data against the electronic data deliverable (EDD) for sample numbers, locations, concentrations, and qualifiers. Further, the project manager or designee will performs a 50% or more check of all positive and non-positive sample results by comparing the hard copy data against the EDD for sample numbers, locations, concentrations, and qualifiers. The data file verification performed by the validation chemist and project manager will likely have some overlap. Once the files are received, they will be appended into the SDMS Lab Analytical table. The "Sample-num" field will be used to link the "Lab Analytical" table with the "Field-Info" table. The table structure is presented below.

Field Name	Type	Size	Description
Sample-num	Character	10	Sample Number
Lab-id	Character	10	Laboratory Sample Identifier
Method	Character	25	Analytical Method Used
L-Matrix	Character	10	Laboratory Matrix
Cas-num	Character	15	Chemical Abstracts
Analyte	Character	40	Analyte Name
Result	Numeric	12.6	Analysis Result
Qual	Character	6	Sample qualifier
Quantitation-Limit	Numeric	12.6	Sample Quantitation Limit
Units	Character	10	Results unit
Date	Date	8	Date analyzed
Lab	Character	40	Lab name





E & E will provide any Geographic Information Systems (GIS)–produced maps, to the EPA in hard copy and digital image (i.e., JPEG) formats.

3

Measurement/Data Acquisition

3.1 Cooler Return

For laboratories other than the EPA MEL, E & E will provide completed air bills accompanied by plastic envelopes with adhesive backs and address labels in the chain-of-custody bags taped to the inside of the cooler lids so the laboratory can return the coolers to E & E. The air bills will contain the following notation: "Transportation is for the United States Environmental Protection Agency, and the total actual transportation charges paid to the carrier(s) by the consignor or consignee shall be reimbursed by the Government, pursuant to cost reimbursement contract number EP-S7-06-02." This notation will enable the laboratories to return the sample coolers to E & E's warehouse. The air bills will be marked for second-day economy service and will contain the appropriate TDD number for shipment.

For the EPA MEL or commercial laboratories, an arrangement by E & E for cooler return in this manner is not required.

3.2 Sample Handling and Custody Requirements

This subsection describes sample identification and chain-of-custody procedures that will be used for the Rock Island Silicon Plant (Former) SI field activities. The purpose of these procedures is to ensure that the quality of the samples is maintained during collection, transportation, storage, and analysis. All chain-of-custody requirements comply with E & E's SOPs for sample handling. All sample control and chain-of-custody procedures will follow the EPA's (2010a) *Final Contract Laboratory Program Guidance for Field Samplers*.

Examples of sample documents used for custody purposes are provided in Appendix D (with the exception of field logbooks) and include the following:

- Sample identification numbers;
- Sample labels;
- Custody seals;
- Chain-of-custody records or traffic reports;
- Field logbooks;
- Sample collection forms; and
- Analytical request forms.



During the field effort, the site manager or delegate is responsible for maintaining an inventory of these sample documents. This inventory will be recorded in a cross-referenced matrix of the following:

- Sample location;
- Sample identification number;
- Analyses requested and request form numbers;
- Chain-of-custody record numbers;
- Bottle lot numbers; and
- Air bill numbers.

Brief descriptions of the major sample identification and documentation records and forms are provided below.

3.3 Sample Identification

All samples will be identified using the sample numbers assigned by the EPA RSCC. Each sample label will be affixed to the jar and covered with clear tape. A sample tracking record will be kept as each sample is collected. The following will be recorded: location, matrix, sample number, observations, and depth. In addition to the EPA-assigned sample number, samples will be tracked with a sample code system designed to allow easy reference to the sample's origin and type. The sample code key will not be provided to the laboratory. Table 3-1 summarizes sample coding for this project.

3.3.1 Sample Labels

To minimize the handling of sample containers, labels will be completed before sample collection, to the greatest extent possible. In the field, the label will be filled out completely using waterproof ink, and then attached firmly to the sample containers and protected with clear tape. The sample label will provide the following information:

- Sample number;
- Sample location number:
- Date and time of collection;
- Analysis required;
- CLP Case number and/or EPA Project code; and
- Preservation (when applicable).

Field sample identification will be sufficient to enable cross-reference with the project logbook. For chain-of-custody purposes, all QA/QC samples will be subject to the same custodial procedures and documentation as site samples.

3.3.2 Custody Seals

Custody seals are preprinted gel-type seals that are designed to break into small pieces if disturbed. Sample shipping containers (e.g., coolers, drums, cardboard boxes, etc., as appropriate) will be sealed in as many places as necessary to ensure



security. Seals will be signed and dated before use. Clear tape will be placed over the seals to ensure that they are not broken accidentally during shipment. Upon receipt at the laboratory, the custodian will check (and certify by completing the package receipt log) that seals on shipping containers are intact.

3.3.3 Chain-of-Custody Records and Traffic Reports

For samples to be analyzed at the EPA MEL or at a CLP laboratory, the chain-of-custody records, analyses required forms, and/or analytical traffic report forms will be completed as described in the *Final Contract Laboratory Program Guidance for Field Samplers* (EPA 2010a). The EPA's SCRIBE software developed by the EPA's Environmental Response Team will be used to enter information electronically. SCRIBE will be used to manage all data generated for the project by capturing sampling data, field observations, field monitoring data, and GPS data. SCRIBE will also be used to generate chain-of-custody and traffic report forms.

The laboratory chain-of-custody records, analyses required forms, and analytical traffic reports will be completed fully by the field technician designated by the site manager as responsible for sample shipment to the appropriate laboratory. Copies of these documents will be in XML format and uploaded to the CLP Sample Management Office (SMO) portal on each day of shipment. Information specified on the chain-of-custody record will contain the same level of detail found in the site logbook, except that the on-site measurement data will not be recorded. The custody record will include the following information:

- Name and company or organization of person collecting the samples;
- Date of sample collection;
- Type of sampling conducted (composite or grab);
- Sample number (using those assigned by the EPA RSCC);
- CLP Case number and/or EPA Project code;
- Location of sampling station (using the sample code system provided in Table 3-1);
- Number and type of containers shipped;
- Analysis requested; and
- Signature of the person relinquishing samples to the transporter, with the date and time of transfer noted and signature of the designated sample custodian at the receiving facility.



If samples require rapid laboratory turnaround, the person completing the chainof-custody record(s) will note these or similar constraints in the remarks section of the custody record.

The relinquishing individual will record all shipping data (e.g., air bill number, organization, time, and date) on the original custody record, which will be transported with the samples to the laboratory and retained in the laboratory's file. Original and duplicate custody records, together with the air bill(s) or delivery note(s), constitute a complete custody record. It is the site manager's responsibility to ensure that all records are consistent and that they become part of the permanent job file.

3.3.4 Field Logbooks and Data Forms

Field logbooks (or daily logs) and data forms are necessary to document daily activities and observations. All data and observations are hand documented in a field logbook. Documentation will be sufficient to enable participants to reconstruct events that occurred during the project accurately and objectively at a later time. All daily logs will be kept in a bound notebook containing numbered pages. All entries will be made in waterproof ink, dated, and signed. No pages will be removed for any reason.

Minimum logbook content requirements are described in the E & E SOP entitled *Field Activity Logbooks*, provided in Appendix C. Any necessary corrections will be made by drawing a single line through the original entry (so that the original entry is legible) and writing the corrected entry alongside. The correction will be initialed and dated. Corrected errors may require a footnote explaining the correction.

3.3.5 Photographs

Photographs will be taken as directed by the team leader. Documentation of a photograph is crucial to its validity as a representation of an existing situation. The following information will be noted in the project or task log concerning photographs:

- Date, time, and location where photograph was taken;
- Photographer (signature);
- Weather conditions;
- Description of photograph taken;
- Reasons why photograph was taken;
- Sequential number of the photograph and the film roll number;
- Camera lens system used; and
- Direction.

3.4 Custody Procedures

The primary objective of chain-of-custody procedures is to provide an accurate written or computerized record that can be used to trace the possession and



handling of a sample from collection to completion of all required analyses. A sample is in custody when it is:

- In someone's physical possession;
- In someone's view;
- Locked up; or
- Kept in a secured area that is restricted to authorized personnel.

3.4.1 Field Custody Procedures

The following guidance will be used to ensure proper control of samples while in the field:

- As few people as possible will handle samples;
- Coolers or boxes containing cleaned bottles will be sealed with a custody tape seal during transport to the field or while in storage before use. Sample bottles from unsealed coolers or boxes, or bottles that appear to have been tampered with, will not be used;
- The sample collector will be responsible for the care and custody of collected samples until they are transferred to another person or dispatched properly under chain-of-custody rules;
- The sample collector will record sample data in the field logbook; and
- The site team leader will determine whether proper custody procedures were followed during the field work and whether additional samples are required.

When transferring custody (i.e., releasing samples to a shipping agent), the following will apply:

- The coolers in which the samples are packed will be sealed and accompanied by one copy of the chain-of-custody record. When transferring samples, the individuals relinquishing and receiving them must sign, date, and note the time on each of the chain of custody record(s). This will document sample custody transfer;
- Samples will be dispatched to the laboratory for analysis with separate chain-of-custody records accompanying each cooler. The chain-of-custody records will be signed by the relinquishing individual, and the method of shipment, name of courier, and other pertinent information will be entered in the chain-of-custody record before placement in the shipping container. Shipping containers will be sealed with custody seals for shipment to the laboratory;
- All shipments will be accompanied by chain-of-custody records identifying their contents. The original custody records will be kept in a zip-locking bag



and will accompany each cooler shipment. The other copies will be distributed appropriately to the site team leader and site manager; and

• If sent by common carrier, a bill of lading will be used. Freight bills and bills of lading will be retained as part of the permanent documentation.

3.4.2 Laboratory Custody Procedures

A designated sample custodian at the laboratory will accept custody of the shipped samples from the carrier and enter preliminary information about the package into a package or sample receipt log, including the initials of the person delivering the package and the status of the custody seals on the coolers (i.e., broken versus unbroken). The custodian responsible for sample log-in will follow the laboratory's SOP for opening the package, checking the contents, and verifying that the information on the chain-of-custody agrees with the samples received. The laboratory will check the temperature blank inside the cooler and document it in the sample log-in form. Should the temperature be greater than what is required by the SOW or the method, the sample custodian will inform the region and follow the course of actions stipulated in the SOW or specified by the regional QAO.

3.5 Analytical Methods Requirements

This subsection describes the analytical strategy (see Section 3.5.1) and the analytical methods (see Section 3.5.2).

3.5.1 Analytical Strategy

Analysis of samples collected during the SI will be performed by several possible means. The MEL (or alternative CLP laboratory designated by the EPA) will perform all requested analysis.

The analyses to be applied to samples sent to the laboratory are listed in Table 1-5. These analyses were selected based on the probable hazardous substances used or potentially released to the environment, given the known or suspected site usage.

3.5.2 Analytical Methods

Samples designated for off-site analytical laboratory analyses will be submitted to the MEL or an alternative laboratory designated by the EPA. MEL laboratory analysis and MEL QA chemist data validation for samples submitted to MEL will take place in an eight-week turnaround time period. CLP laboratory analyses will take place within the standard three-week turnaround time period, with validation by the EPA QA Office for these analyses taking place within the standard three-week turnaround time period. Hardcopy results from the MEL and/or CLP laboratories will be delivered to the EPA upon completion of each sample delivery group. Electronic results from the MEL and/or CLP laboratories will be delivered to the EPA upon project completion. Table 1-5 summarizes laboratory instrumentation and methods to be used for the Rock Island Silicon Plant (Former) Site.



For cases in which laboratory results exceed QC acceptance criteria, reextraction and/or reanalysis will occur as indicated in the applicable analytical method.

3.6 Quality Control Requirements

QC checks for sample collection will be accomplished by a combination of chainof-custody protocols and laboratory QA procedures as prescribed in the sampling or analytical methods. No QC samples (i.e., double blind performance evaluation samples) are planned for this activity outside of the normal laboratory QC criteria outlined in the analytical methods. These QC samples include blanks (field and/or laboratory method), calibration verifications, spikes, duplicates, interference check samples (for inorganics), and serial dilutions. Results from these samples will be compared to the QC requirements listed in Subsection 5.1.2. All analyses that will be performed for this project will produce definitive data. DQI targets for this project are specified in Subsection 2.2 and are summarized in Table 1-5 of this SQAP. Bias for estimated qualified data will be determined by the validation process. In accordance with the objectives outlined in this document and the QA levels defined by the EPA (1993), the EPA has defined the DQOs and has determined that the sampling and analyses performed under this sampling effort will conform to the definitive data without quantitative error and bias determination criteria. The laboratories' DQOs for completeness and the field team's ability to meet the DQO for representativeness are set at 90%. Precision and accuracy requirements are outlined in Table 1-5

One temperature blank consisting of a 40-milliliter container of distilled water will be included in each cooler shipped to the analytical laboratories. Temperature blanks allow the laboratories to obtain a representative measurement of the temperature of samples enclosed in a cooler without disturbing the actual samples. The field team will package and label the temperature blank like a regular water sample; however, the analytical laboratory will only measure the temperature of the blank. The temperature blank will not be analyzed for hazardous substances, will not be given a sample number, and will not be listed on the chain-of-custody form. The temperature blank will be clearly labeled: USEPA COOLER TEMPERATURE INDICATOR.

3.7 Instrument/Equipment Testing, Inspection, and Maintenance Requirements

The field equipment used during this project includes the GPS unit, a photoionization detector/flame ionization detector, a HoribaTM water quality meter, and a water level indicator. Testing, inspection, and maintenance of these instruments will be performed in accordance with the manufacturers' recommendations and/or the SOPs listed in Section 1.5.3. Spare parts for the field equipment will be available from the manufacturer generally within 24 hours.

All field instruments and equipment used for analysis will be serviced and maintained only by qualified personnel. All instruments will be maintained by senior staff and/or electronics technicians. All repairs, adjustments, and



calibrations will be documented in an appropriate logbook or on a data sheet that will be kept on file. The instrument maintenance logbooks will clearly document the date, description of the problems, corrective action taken, result of the action, and who performed the work.

All equipment used by E & E in the field is subject to standard preventive maintenance schedules established by corporate equipment protocols. When in use, equipment will be inspected at least twice daily: once before startup in the morning and again at the end of the work shift before overnight storage or return to the charging rack. Regular maintenance, such as cleaning of lenses, replacement of in-line filters, and removal of accumulated dust, is to be conducted according to manufacturers' recommendations and in the field as needed, whichever is appropriate. All performed preventive maintenance will be entered in the individual equipment's logbook and in the site field logbook.

In addition to preventive maintenance procedures, daily calibration checks will be performed at least once daily before use and recorded in the respective logbooks. Additional calibration checks will be performed as required. All logbooks will become part of either the permanent site file or the permanent equipment file.

3.8 Instrument Calibration and Frequency

All instruments and equipment used during fixed laboratory sample analyses will be operated, calibrated, and maintained according to the manufacturers' guidelines and recommendations, as well as criteria set forth in the applicable analytical methodology references and/or in accordance with the laboratory's QA manual and SOPs.

For the field instrumentation (GPS unit and other instrumentation discussed previously), calibrations will be performed in accordance with the manufacturers' recommendations and the SOPs listed in Section 1.5.3.

3.9 Inspection/Acceptance Requirements for Supplies and Consumables

This information is covered by the SOPs, the START-3 QAPP (E & E 2010b), and the START-3 QMP (E & E 2010a). Standards contained in these documents will be used to ensure the validity of data generated by E & E for this project. Sample jars are pre-cleaned by the manufacturer; and certification documenting this is enclosed with each box of jars. The START-3 will include this documentation as part of the site file. Nondedicated equipment is demonstrated to be uncontaminated by the use of rinsate blanks.

3.10 Data Acquisition Requirements (Non-direct Measures) No data will be used from other sources.





3.11 Data Management

This document is meant to be combined with information presented in E & E's QAPP and QMP for Region 10 START-3. Copies of the START-3 QAPP and QMP are available in E & E's Seattle office. Standards contained in these documents will be used to ensure the validity of data generated by E & E for this project. Data validation will be performed as listed in Section 5.1.2. Electronic data will be archived by TDD.



4

Assessment/Oversight

4.1 Assessment and Response Actions

The EPA QAO or designee may conduct an audit of the field activities for this project. The auditor will have the authority to issue a stop work order upon finding a significant condition that adversely would affect the quality and usability of the data. The EPA TM will be responsible for initiating and implementing response actions associated with findings identified during the site audit. The actions taken also may involve the EPA PO, contracting officer, and/or QAO. Once the response actions have been implemented, the EPA QAO or designee may perform a follow-up audit to verify and document that the response actions were implemented effectively. In-house audits performed by the START-3 may be conducted in accordance with the E & E START-3 *Quality Management Plan* (2010a). No audits are planned for the Rock Island Silicon Plant (Former) SI.

If major deviations from the QA requirements of the project and the CLP SOW were observed in the data validation process, the EPA QAO will contact the laboratory to correct the problem. If the laboratory is not responsive to the request, the QAO will inform the CLP Regional PO and the TM of the situation. A brief narrative will be written explaining the contract deviations, and recommendations will be given based on the quality of the submitted data. Reduced payment and/or reanalysis at the laboratory's expense may be pursued by the Regional CLP PO. Re-sampling and subsequent re-analysis will be decided by the TM. Additional sampling for corrective actions and/or any addendum to this SQAP shall be documented using the Corrective Action Form and the SPAF (see Appendix B). Corrective actions will be conducted in accordance with E & E QMP specifications.

4.2 Reports to Management

The START-3 PM will debrief the EPA TM on a daily basis. Laboratory deliverables will be as specified in the CLP Inorganic SOW (ILM01.2) for CLP data and CLP-equivalent deliverables for MEL data. Once the project is complete and the resulting data obtained, the START-3 PM will prepare a final project report. The report will include a summary of the activities performed during the project and the resulting data (along with any statements concerning data quality). The report will be approved by the EPA TM prior to being forwarded to the



4. Assessment/Oversight

individuals identified in the data distribution list located in the Table of Contents section of this SQAP.

The START-3 corrective action program is addressed in Section 3 of the QMP. Corrective actions will be conducted in accordance with these QMP specifications.

5

Data Validation and Usability

5.1 Data Review, Validation, and Verification Requirements

The data validation review of data packages will include an evaluation of the information provided on the analytical data sheets and required support documentation for all sample analyses; the supporting sample collection documentation, including chain-of-custody forms; and documentation of field instrument calibration, sample results, and/or performance checks (if required by the method). The QA review also will examine adherence to the procedures as described in the cited SOPs and the specified analytical methods in the SQAP.

5.1.1 Data Reduction

Data reduction includes all processes that change the numerical value of the raw data. All fixed-laboratory data reduction will be performed in accordance with the appropriate methodology and will be presented as sample results.

5.1.2 Data Validation

Analytical data generated through the CLP contract will be validated in a three-week turn-around time by the Region 10 QA staff or its designee. Data generated by the MEL will be reviewed and qualifiers will be applied by staff at the MEL. Data generated by CLP laboratories will receive Stage 4 (S4VEM) validation by the Region 10 QA staff (EPA 2009). All data validations will be performed in accordance with the QA/QC requirements specified in the SQAP, the technical specifications of the analytical methods, laboratory SOPs (for non-CLP methods), and the following document:

 USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Superfund Data Review (EPA 2010b).

The QC parameters of interest for the EPA inorganic method that will be used on the Rock Island Silicon Plant (Former) SI samples are presented in these documents. When applicable, QC criteria listed in the applicable analytical methods will be used for validation. Sample qualifications based on field blank results (when collected) will be applied in the same manner as qualifications based on laboratory method blank results.



Validation deliverables will include a QA memo discussing QA conformance and deviation issues that may have affected the quality of the data. Data usability, bases of application of qualifiers, and percentage of qualified data will also be discussed in the QA memo. The analysis data sheets (Form I or equivalent) with the applied validation qualifiers will also be a part of the validation deliverables. MEL staff performs verification of data generated at the EPA laboratory. Data qualifiers will be determined by the EPA QA staff for CLP generated data. The following qualifiers shall be used in data validation:

- U = The material was analyzed for but was not detected. The associated numerical value is the sample quantitation limit.
- J = The associated numerical value is an estimated quantity because the reported concentrations were less than the sample quantitation limits or because quality control criteria limits were not met.
- UJ = The material was analyzed for but was not detected. The reported detection limit is estimated because QC criteria were not met.
- R = The sample results are rejected (analyte may or may not be present) due to gross deficiencies in quality control criteria. Any reported value is unusable. Re-sampling and/or reanalysis is necessary for verification.
- H = High bias.
- K = Unknown bias.
- L = Low bias.
- Q = Detected concentration is below the method reporting limit/Contract Required Quantitation Limit, but is above the method quantitation limit.

5.1.3 Data Assessment Procedures

Following data validation and reporting, all project-generated and compiled data and information will be reconciled with the objectives specified in Section 1.3.1 to assess the overall success of SI activities. This data assessment, including points of achievement and departure from project-specific objectives, will be discussed in the QA section of the SI report.

5.2 Data Verification

The analytical QA requirements and data validation requirements will be as specified in Section 5.1.2 (EPA 2010b).

The EPA TM will perform the final review and approval of the data. The EPA TM and/or QA staff will look at matrix spike/matrix spike duplicates, laboratory blanks, and laboratory duplicates to ensure that they are acceptable. The EPA TM





and/or designee also will compare the sample descriptions with the field sheets for consistency and will ensure that any anomalies in the data are documented appropriately.

Data QA memoranda reports will be generated as part of the Rock Island Silicon Plant (Former) SI if the START-3 is responsible for data validation. If the EPA Region 10 QA office or its designee performs the data validation, then additional reports regarding data usability will be generated by the START-3.

5.3 Reconciliation with Data Quality Objectives

The DQI target for this project is discussed in Section 2.2.2 of this SQAP. The data validation will be used as a tool to determine if these targets were met. In addition, using the compiled data, E & E and the TM will determine the variability and soundness of the data and the data gaps that will need to be filled to meet the objectives of the project.

Once the data results are compiled, the EPA TM and/or the EPA QAO will review the sample results to determine if they fall within the acceptance limits as defined in this SQAP. Completeness also will be evaluated to determine if the completeness goal for this project has been met. If DQIs do not meet the project's requirements as outlined in this SQAP, the data may be discarded and resampling and reanalysis may be done. The TM will attempt to determine the cause of the failure (if possible) and make the decision to discard the data and resample. If the failure is tied to the analysis, calibration and maintenance techniques will be reassessed, as identified by the appropriate laboratory personnel. If the failure is associated with the sample collection and resampling is required, the collection techniques will be reevaluated as identified by the START-3 PM.

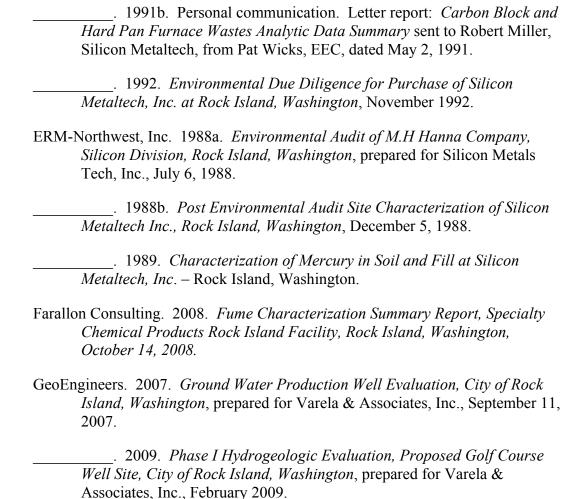


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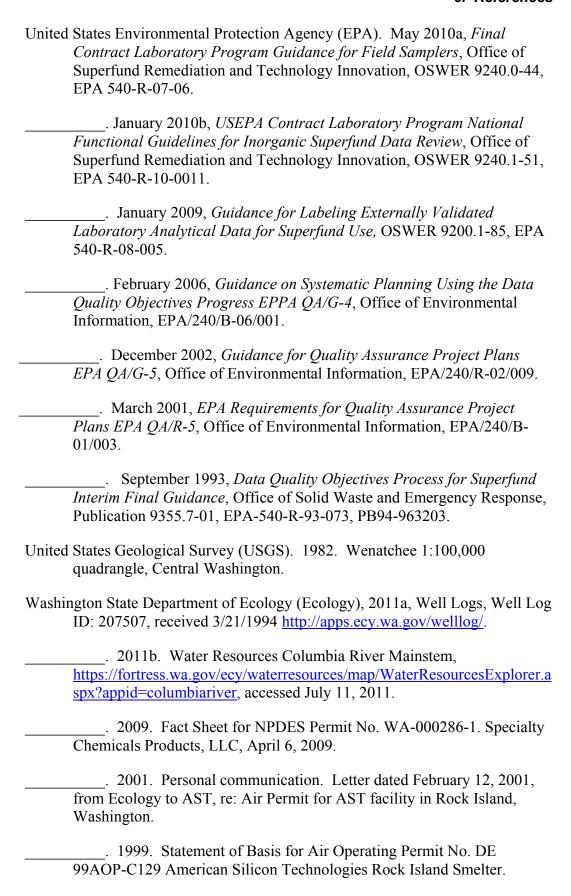
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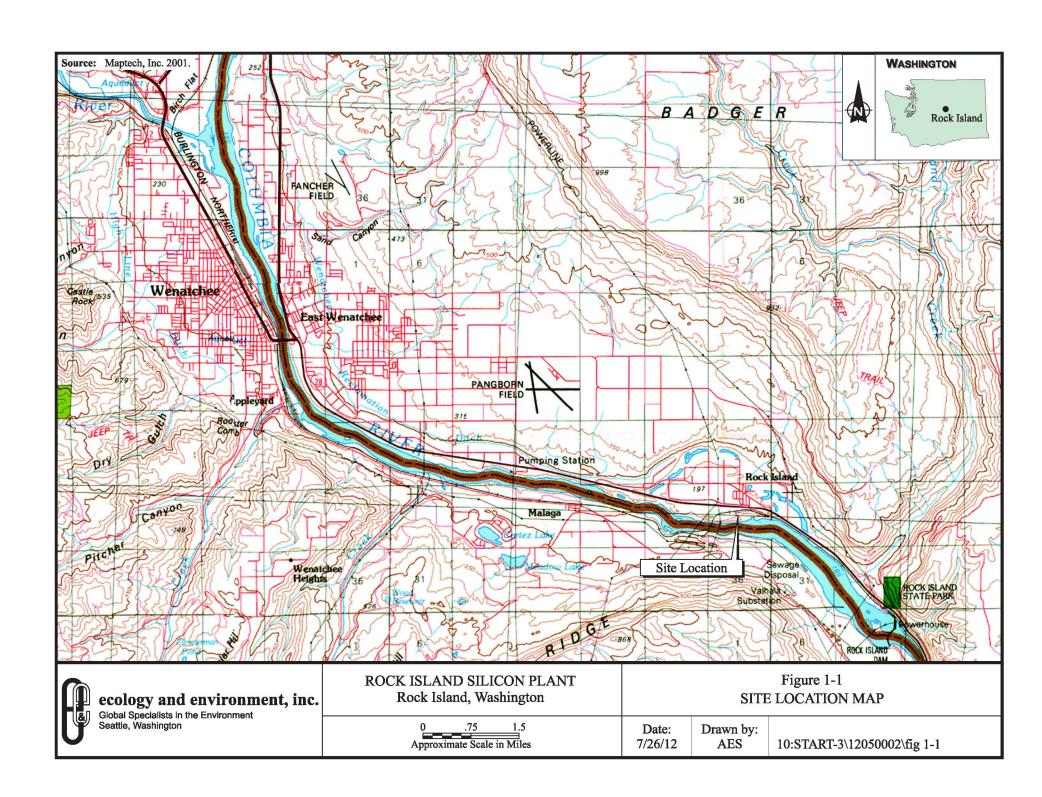


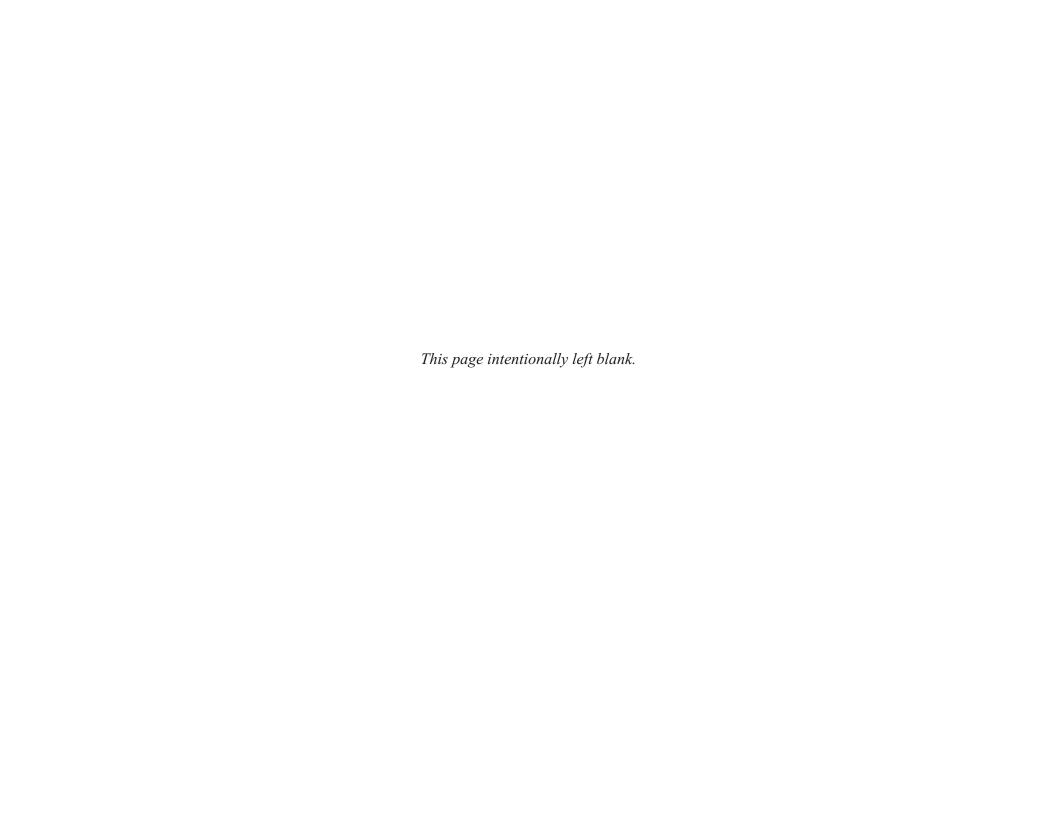


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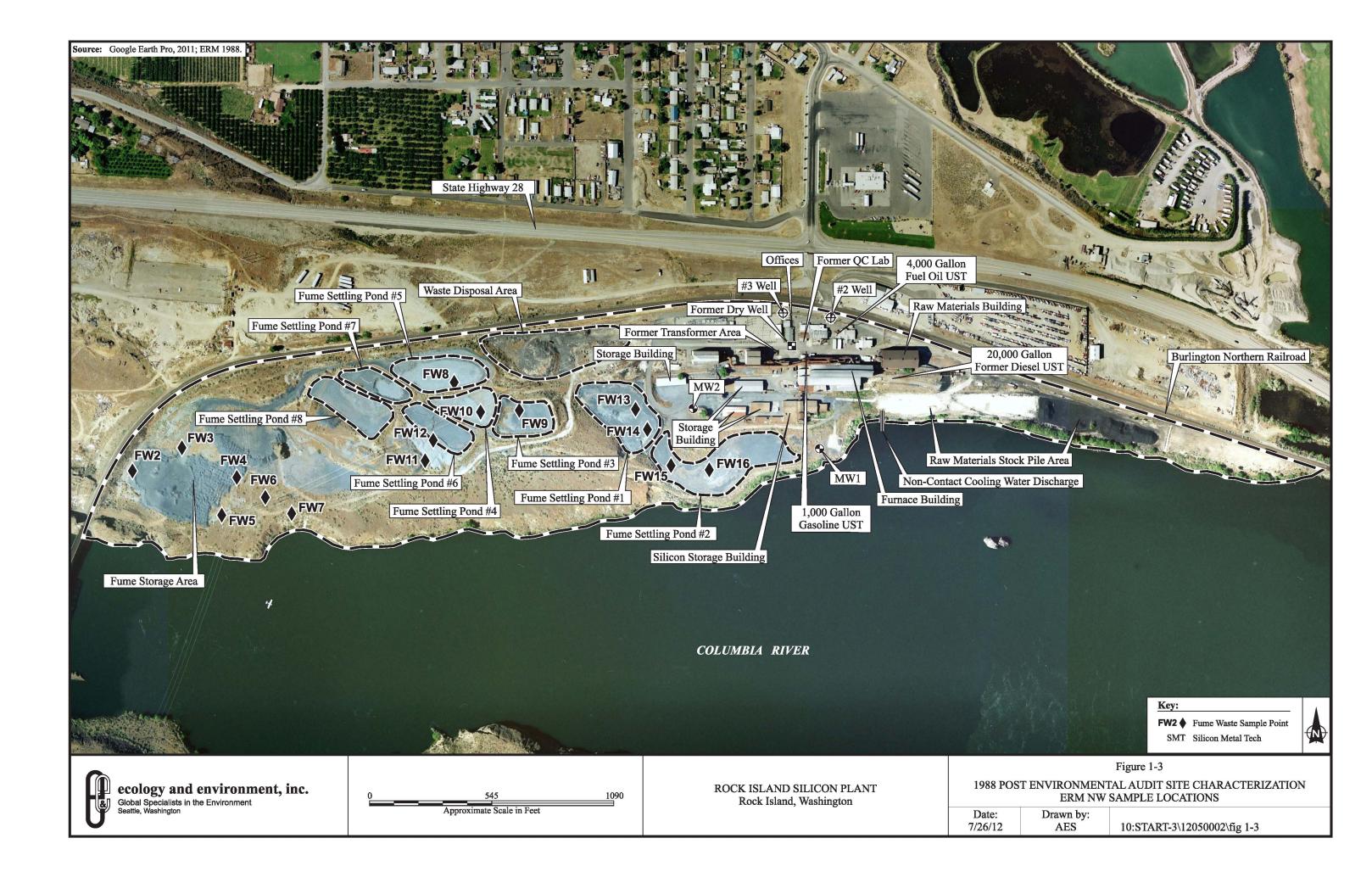




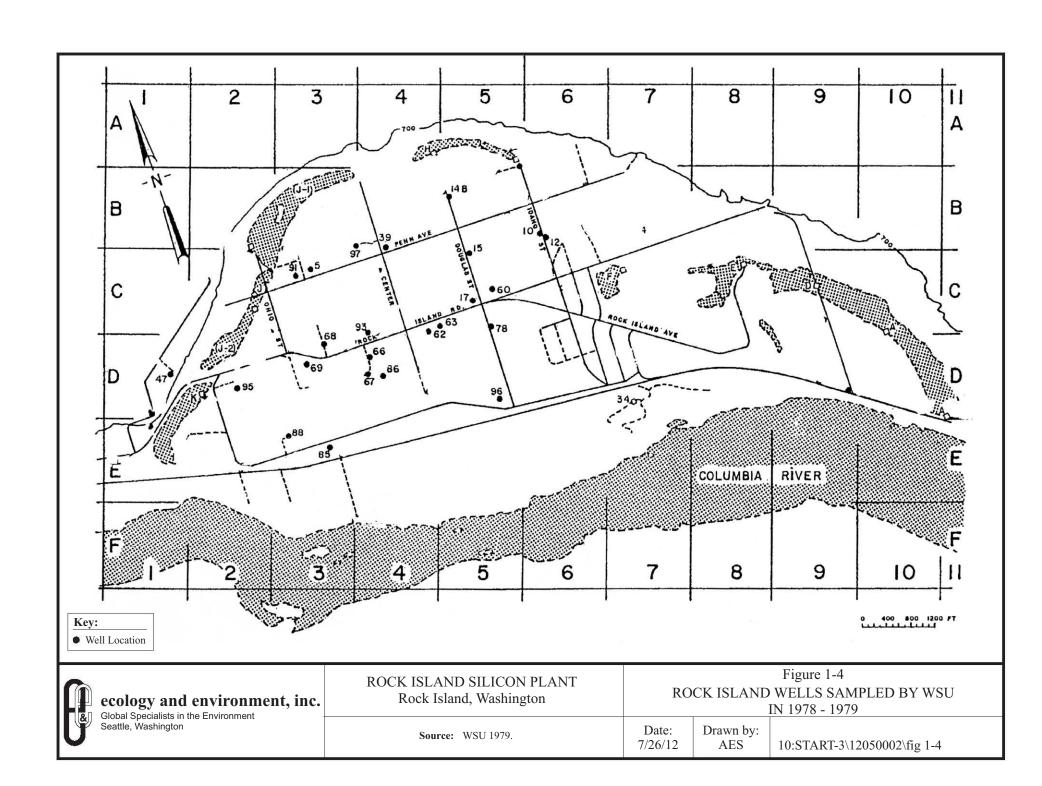


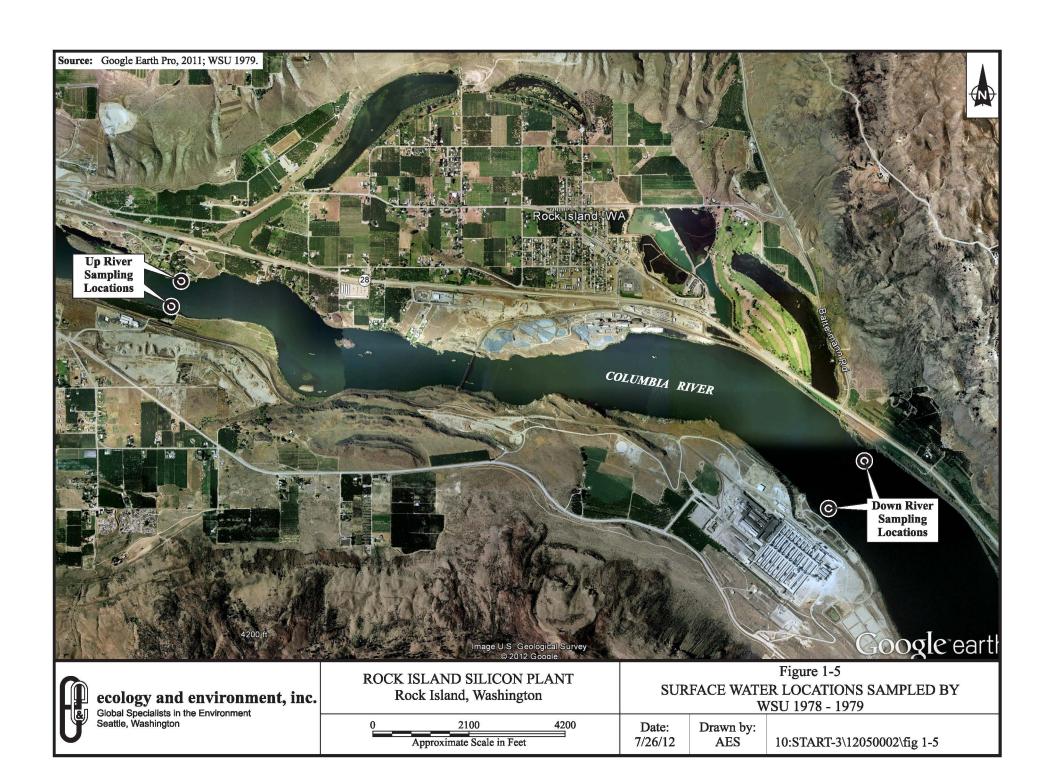


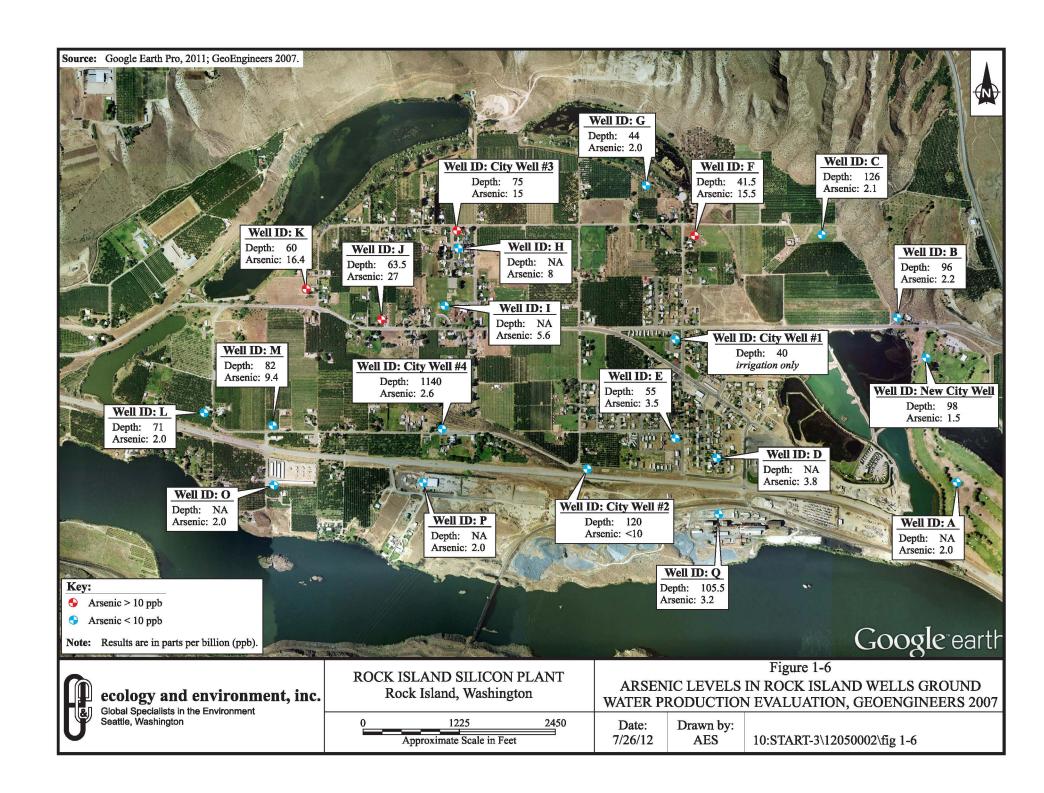


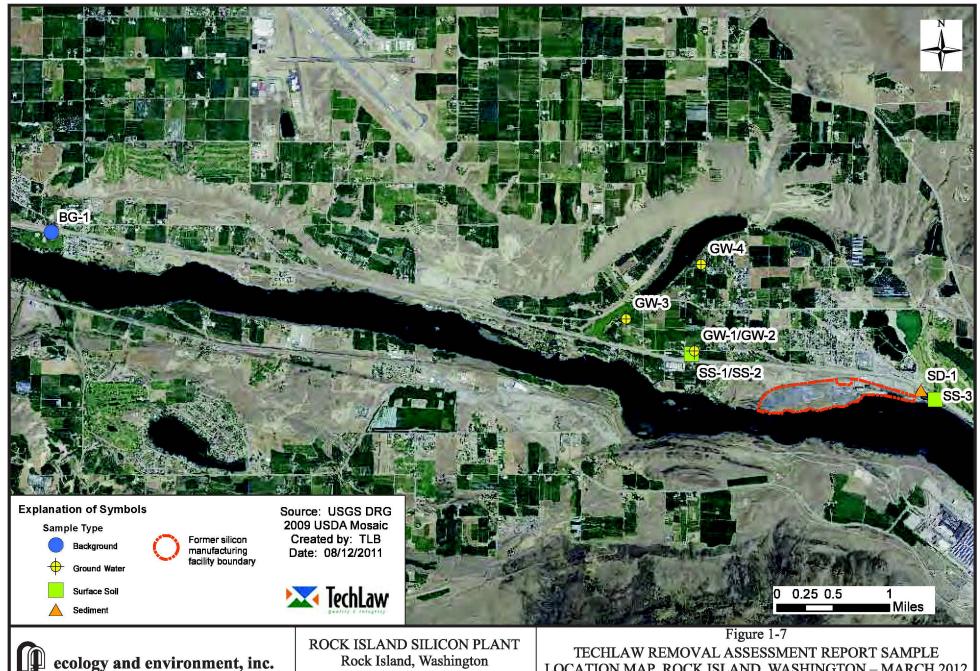














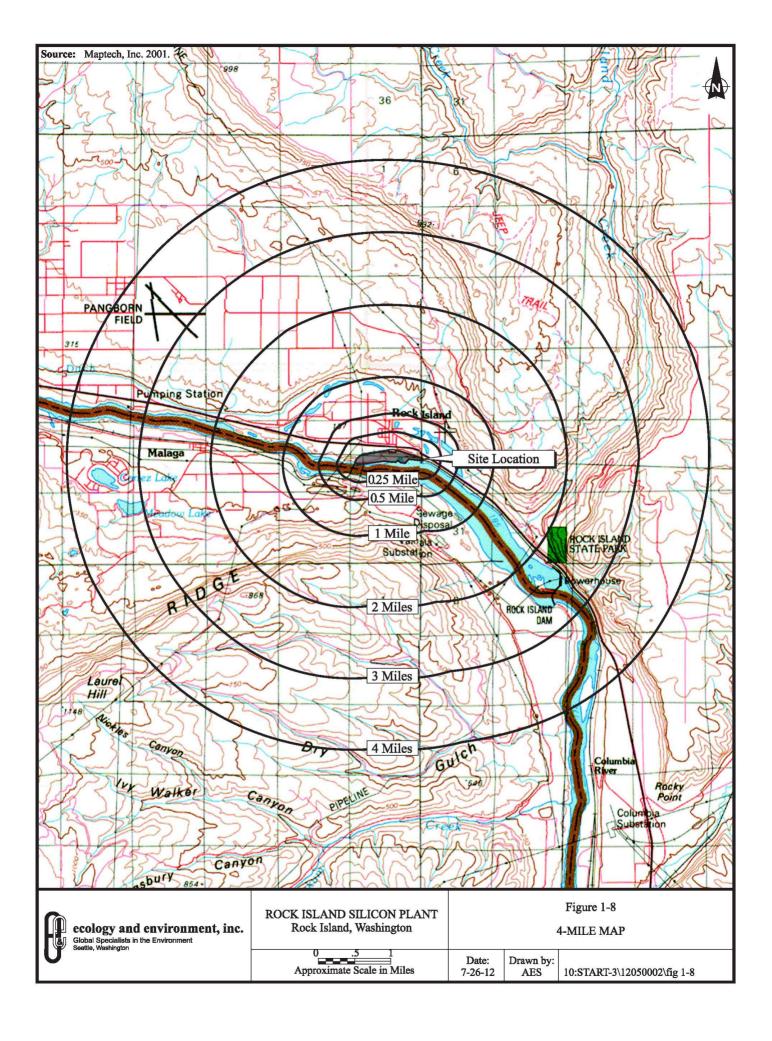
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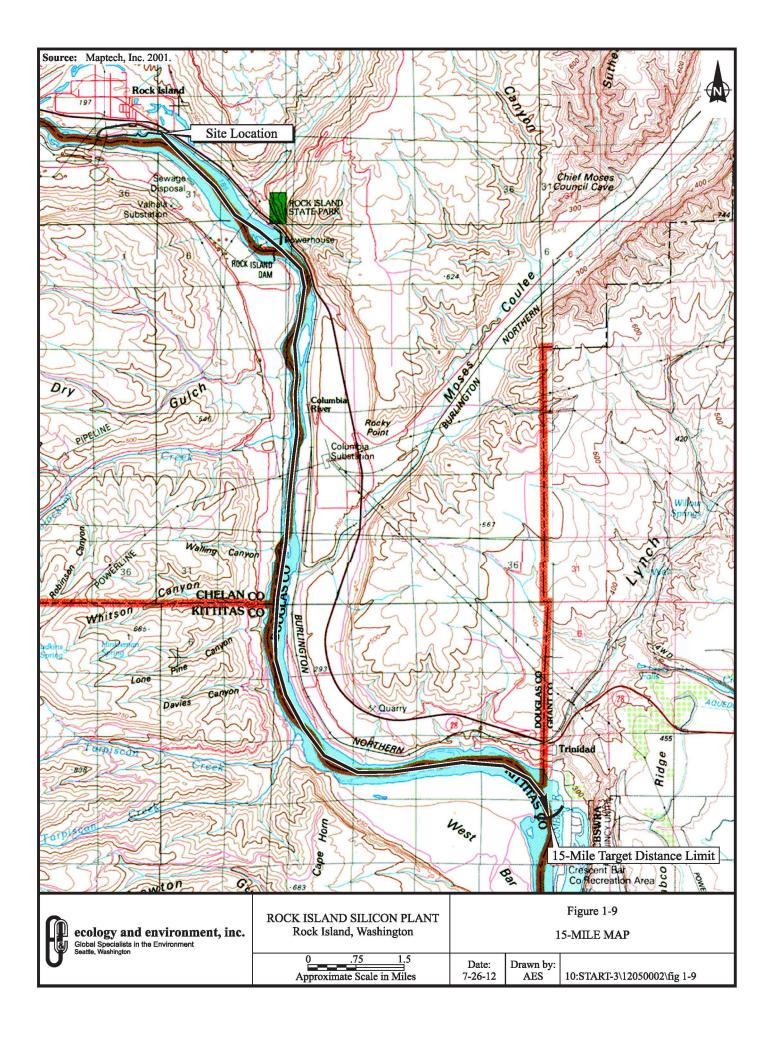
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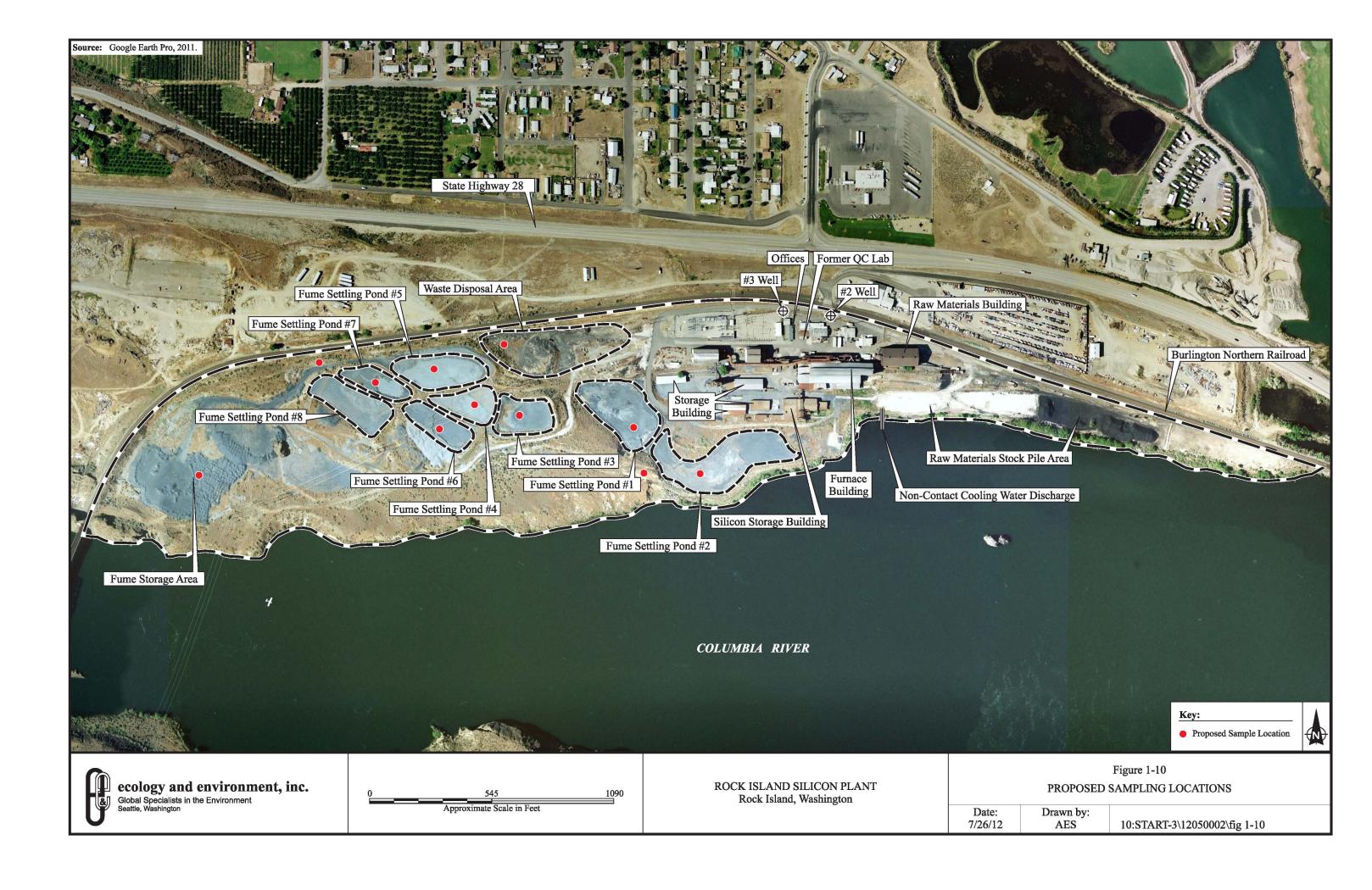
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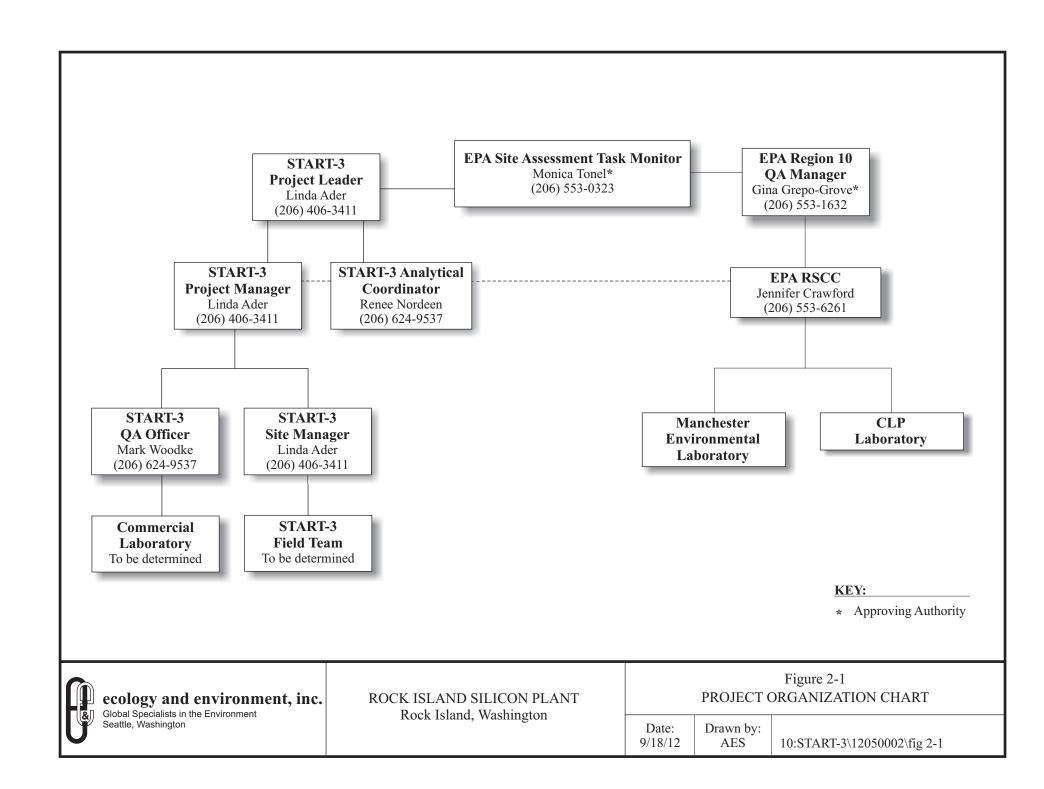
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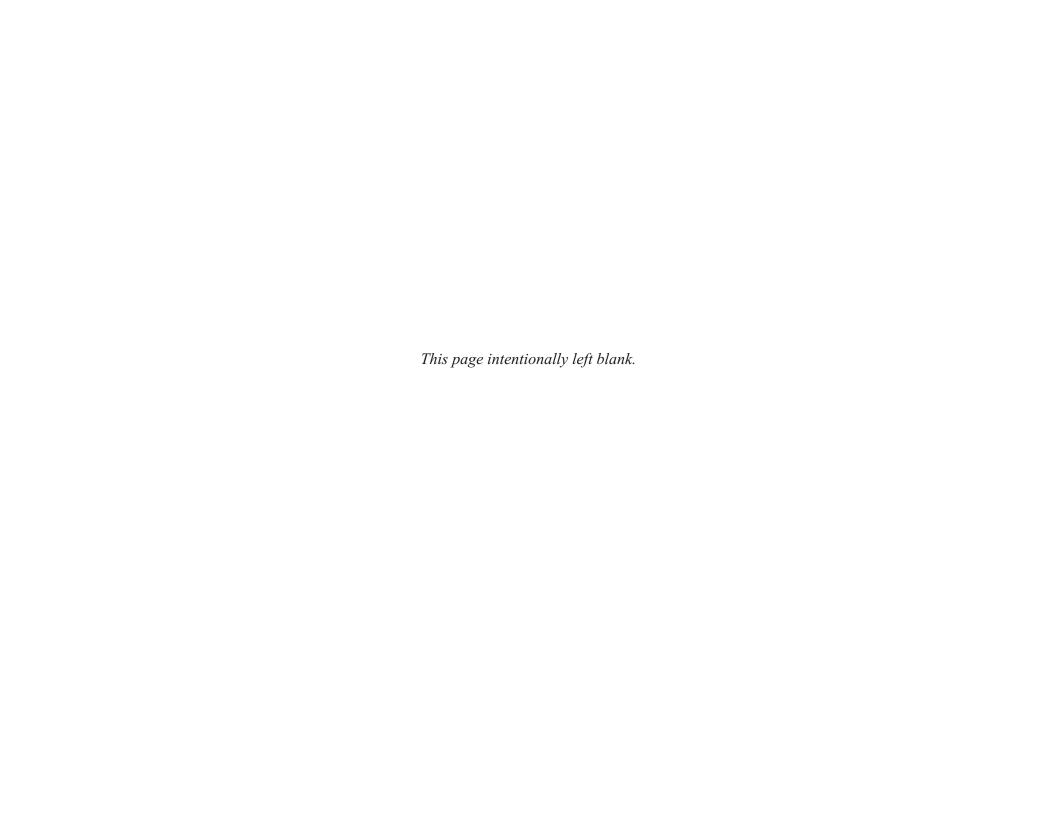












Tables



Table 1-1 Summary of Analytical Results for Total Metals (mg/kg)

	Fume Ponds						ne Storage A	MTCA Method A or B	
Analyte	FW9	Composite FW8 & FW10	Composite FW11 & FW12	Composite FW13 & FW14	Composite FW15 & FW16	Composite FW2 & FW3	Composite FW4 & FW5	Composite FW6 & FW7	Cleanup Level for Unrestricted Land Use
Date	10/4/1988	10/4/1988	10/4/1988	10/4/1988	10/4/1988	10/4/1988	10/4/1988	10/4/1988	USE
Antimony	<8.2	<2.2	2.5	2.5	<2.4	<2.4	<2.3	2.2	32
Arsenic	<9.2	7.6	12	16	9.7	19	12	19	20
Beryllium	<2.1	< 0.76	< 0.87	< 0.87	< 0.85	< 0.85	< 0.76	< 0.77	160
Cadmium	< 0.61	0.97	1.6	1.1	< 0.24	1.4	7.6	1.8	2
Chromium	9.2	13	20	19	17	19	20	14	19
Copper	40	68	49	63	4.8	47	54	56	3,000
Lead	18	200	250	200	45	240	150	210	250
Mercury	0.034	0.106	0.063	0.261	0.025	0.051	0.051	0.411	2
Nickel	19	7.6	6.2	17	3.6	12	20	15	1,600
Selenium	<9.2	<3.2	<3.7	<3.7	<3.6	<3.6	<3.3	<3.3	400
Silver	<3.1	<1.1	1.2	<1.2	<1.2	2.2	<1.1	1.1	400
Thallium	<9.2	<3.2	<3.7	<3.7	<3.6	<3.6	<3.3	<3.3	5.6
Zinc	64	380	440	300	88	370	220	270	24,000

Source: Farallon Consulting 2008

Note: **Bold** type indicates the sample result is above the detection limit.

Highlight indicates concentrations above cleanup levels.

Key:

< = Less than the detection limit.

mg/kg = milligrams per kilogram.

Table 1-2 Summary of Analytical Results for Total Metals - EP Toxicity and TCLP Leachate (mg/L)

	Fume Ponds							Fume Storage Area		rea			
Analyte	1 FW/9	•	Composite FW11 & FW12	Composite FW13 & FW14	Composite FW15 & FW16	Composite FW13 & FW15	FW8	Composite FW11 & FW12	Composite	Composite FW2 & FW3		Composite FW6 & FW7	TCLP Regulatory Levels
Date	10/4/1988	10/4/1988	10/4/1988	10/4/1988	10/4/1988	3/13/1991	3/13/1991	3/13/1991	7/19/1996	10/4/1988	10/4/1988	10/4/1988	8/17/2011
Arsenic	0.22	0.33	0.36	0.27	0.21	0.4	0.2	0.4	< 0.1	0.22	0.36	0.36	5
Barium	<1.0	<1.0	<1.0	<1.0	<1.0	1.0	1.2	0.6	< 0.5	<1.0	<1.0	<1.0	100
Cadmium	0.09	0.16	0.016	0.13	0.11	< 0.01	< 0.01	< 0.01	< 0.01	0.2	0.13	0.15	1
Chromium	< 0.05	< 0.05	0.14	< 0.05	< 0.05	< 0.01	0.01	< 0.01	< 0.01	< 0.05	< 0.05	< 0.05	5
Copper	< 0.05	1.4	0.82	0.34	0.25					0.42	0.35	0.39	NE
Lead	0.14	3.9	4.1	1.3	0.69	0.26	0.22	0.15	< 0.05	2.5	1.2	1.7	5
Mercury	< 0.001	< 0.001	< 0.001	0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.002	0.2
Nickel	0.11	0.16	0.07	< 0.05	< 0.05					0.07	0.16	0.07	NE
Selenium	< 0.05	0.08	0.09	0.07	0.06	< 0.1	< 0.1	0.1	< 0.1	0.09	0.08	0.04	1
Silver	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.01	< 0.01	< 0.01	< 0.01	< 0.05	< 0.05	< 0.05	5
Zinc	0.89	16	11	4.0	2.0					9.0	3.0	6.0	NE

Source: Farallon Consulting 2008

Note: **Bold** type indicates the sample result is above the detection limit.

Samples analyzed in 1988 used the EP Toxicity method. Samples analyzed in 1991 and 1996 used the TCLP method.

Key:

-- = Not analyzed.

< = Less than the detection limit.

EP Toxicity = Extraction Procedure Toxicity Test Method.

mg/L = milligrams per liter.

NE = Not established.

TCLP = Toxicity Characteristic Leaching Procedure.

Table 1-3 Well Population by Distance Ring

Distance Ring	Residential Population	Public Well Population	Total
0 to 1/4 mile	27	0	27
¹⁄₄ to ¹⁄₂ mile	45	1,043	1,088
½ to 1 mile	105	0	105
1 to 2 miles	168	0	168
2 to 3 miles	112	0	112
3 to 4 miles	123	0	123
TOTAL	580	1,043	1,623

Source: Ecology 2011; City of Rock Island 2007

Table 1-4 Sample Information Summary

Project Sampling Schedule ^a	Design Rationale	Sampling Design Assumptions	Measurements Classification (Critical/Noncritical)	Nonstandard Method Validation
Soil	Determine if	Contaminants are	Critical	NA
(surface and	contaminants are	present in site		
subsurface)	present.	sources		
Ground	Determine if	Contaminants are	Critical	Anions,
Water	contaminants are	present in site		alkalinity, and
	present or are	sources and may be		bicarbonate per
	migrating from	migrating from site		method
	site sources	sources		

Key:

NA = Not applicable.



Table 1-5 Sample Analysis Summary and QA/QC Analytical Summary and Fixed Laboratory Analytical Methods

Matrix/ Location ^a	Proposed Laboratory	Analytical Parameters/Methods/Description and Detection Limits	Precision and Accuracy b	Technical Holding Times	Sample Preservation (all 4°C <u>+</u> 2°C)	Sample Containers/MS Duplicate Sample Containers	Number of Field Samples	Number of MS Duplicate Samples	Total Number of Sample Containers
Soil	MEL or CLP	TAL Metals/ EPA CLP SOW ISM01.3 or EPA SW-846 6000/7000 Series/ ICP-AES/CRQL	± 35% 75% - 125%	180 days	N/A	1x8-ounce glass/ 1x8-ounce glass	49	3	49
		Mercury/ EPA CLP SOW ISM01.3 or EPA SW-846 7471B/CVAA/CRQL	± 35% 75% - 125%	28 days for Hg	N/A				
Water (17 Ground water and 7 IDW water)	(17 Ground water	TAL Metals/ EPA CLP SOW ISM01.3 or EPA SW-846 6000/7000 Series/ ICP-MS/CRQL	± 20% 75% - 125%	180 days	$pH \le 2$ with HNO_3	1x1-liter polyethylene/ 2x1-liter polyethylene	24	2	26
		Mercury/ EPA CLP SOW ISM01.3 or EPA 245.1/CVAA/CRQL	± 20% 75% - 125%	28 days					
		Anions (Sulfate, Nitrate, Bromide, Chloride)/EPA 300/Ion Chromatography/20 µg/L ^d	± 20% 75% - 125%	48 hours	N/A	1x1-liter polyethylene/ 2x1-liter polyethylene	17	1	18
		Anions (Sulfate, Bromide, Chloride)/EPA 300/Ion Chromatography/20 µg/L ^d	± 20% 75% - 125%	28 days					
		Alkalinity and Bicarbonate/EPA 310.2 and SM 2320B/Colorimetric and Titration/10 mg/L and 5 mg/L	± 20% 75% - 125%	14 days	N/A	1x1-liter polyethylene/ 2x1-liter polyethylene	17	1	18
QA/QC Samples (5 rinsates)	MEL or CLP	TAL Metals/ EPA CLP SOW ISM01.3 or EPA SW-846 6000/7000 Series/ ICP-MS/CRQL	± 20% 75% - 125%	180 days	$pH \le 2$ with HNO_3	1x1-liter polyethylene/NA ^e	5	0	5
Note:		Mercury/ EPA CLP SOW ISM01.3 or EPA 245.1/CVAA/CRQL	± 20% 75% - 125%	28 days					

Note:

a = The number of samples presented is an estimate. The actual number of samples to be collected will be determined in the field.

b = Precision and accuracy are per method or SOW, as appropriate. In some cases, generic limits are listed in this table for comparison purposes.

c = Technical holding times have been established only for water matrices. Water technical holding times were applied to sediment, soil, and product samples where applicable; in some cases, recommended sediment/soil holding times are not listed.

d = Anions with Nitrate will be selected for analysis when a sample contains >2 ppm nitrate based on field test strips. Otherwise, anions without nitrate will be selected.

e = No MS/MSD and laboratory duplicate samples are not being collected for water QA/QC samples as these are field rinsate and/or trip blank samples collected only for QA/QC purposes.

Key:

 $\begin{array}{ll} mg/L = & \text{Milligrams per liter.} \\ \mu g/L = & \text{Micrograms per liter.} \end{array}$

AES = Atomic Emission Spectrometer
CLP = Contract Laboratory Program
CRQL = Contract Required Quantitation Limit

EPA = United States Environmental Protection Agency

 $HNO_3 =$ Nitric acid

ICP = Inductively coupled argon plasma

MEL = Manchester Environmental Laboratory

MS = Mass spectrometric detection

MS/MSD = Matrix spike/matrix spike duplicate

ppm = Parts per million SOW = Statement of Work TAL = Target Analyte List



Table 1-6 Proposed Schedule

Activity	Start Date	Completion Date
Collect pertinent background information		
Mobilize to the site	October 28, 2012	October 28, 2012
Sample collection activities	October 29, 2012	November 1, 2012
Laboratory receipt of samples	October 31, 2012	November 2, 2012
Demobilization from the site	November 2, 2012	November 2, 2012
Laboratory analysis	November 5, 2012	December 3, 2012
Data validation	December 3, 2012	December 31, 2012
Writing of the draft project report	November 5, 2012	February 11, 2013
Responding to EPA comments and	February 25, 2013	March 11, 2013
submittal of final report		
Target project completion date	March 31, 2013	March 31, 2013

Table 3-1 Sample Coding

Digits	Description	Code	Example
1,2	Source Code	FP	Fume Pond
		FS	Fume Storage Area
		WD	Waste Disposal Area
		BG	Background
		AR	Area Residence
3,4	Consecutive Number	01	First number of source code
5,6	Matrix Code	GW	Ground Water
		SB	Subsurface Soil
		SS	Surface Soil
		WT	Water
7,8	Consecutive Number	01	Lowest depth of sample matrix



A Site Photographs



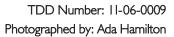




Photo 1 Western edge of site - raised railroad.

Direction: West Date: 10/25/11 Time: 11:03



Photo 3 Waste disposal area and river.

Direction: East Date: 10/25/11 Time: 11:07

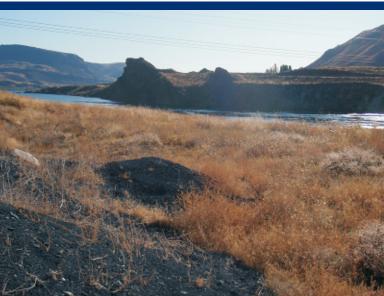


Photo 2 View of river at edge of waste disposal area.

Direction: East Date: 10/25/11 Time: 11:06



Photo 4 Fume in former pond.

Direction: North Date: 10/25/11 Time: 11:07

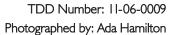




Photo 5 Fume in former pond.

Direction: North Date: 10/25/11 Time: 11:09



Photo 7 Fume pond #7.

Direction: East Date: 10/25/11 Time: 11:20



Photo 6 Columbia River - possible runoff from ponds.

Direction: South Date: 10/25/11 Time: 11:10



Photo 8 Fume pond.

Direction: South Date: 10/25/11 Time: 11:23



Photo 9 Land fill - carbon rod.

Direction: North Date: 10/25/11 Time: 11:33



Photo 11 Overview of land fill.

Direction: East Date: 10/25/11 Time: 11:35



Photo 10 Land fill - edge of hill.

Direction: East Date: 10/25/11 Time: 11:33



Photo 12 Older fume pond and Columbia River.

Direction: South Date: 10/25/11 Time: 11:38

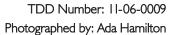




Photo 13 Fume settling pond #1.

Direction: South Date: 10/25/11 Time: 11:41

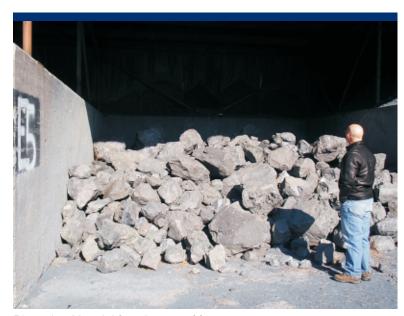


Photo 15 Material from bottom of furnace.

Direction: North Date: 10/25/11 Time: 11:50

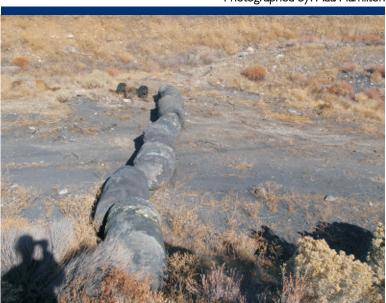


Photo 14 Land fill - solid waste disposal area

Direction: North Date: 10/25/11 Time: 11:42



Photo 16 Bins for material storage.

Direction: West Date: 10/25/11 Time: 11:51



Photo 17 Area of former buildings.

Direction: East Date: 10/25/11 Time: 11:53

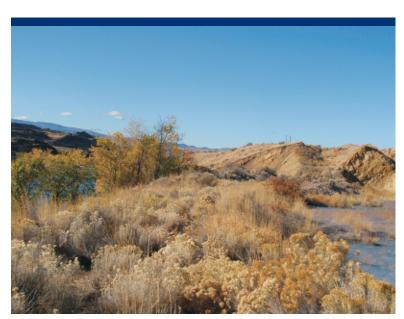


Photo 19 Natural berm at pond #2 (separated from river).

Direction: West Date: 10/25/11 Time: 11:58



Photo 18 Former original pond (pond #2).

Direction: East Date: 10/25/11 Time: 11:55

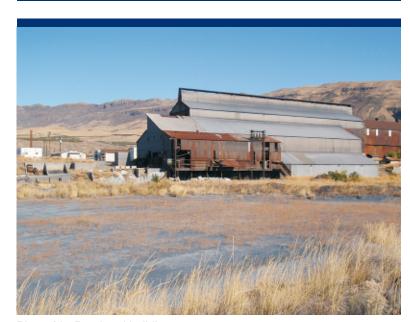


Photo 20 Pond and building.

Direction: North Date: 10/25/11 Time: 11:59

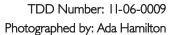




Photo 21 Pile with potential to runoff to river.

Direction: East Date: 10/25/11 Time: 12:02

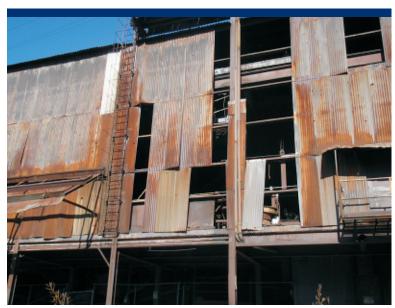


Photo 23 Furnace building with tapping area.

Direction: North Date: 10/25/11 Time: 12:10

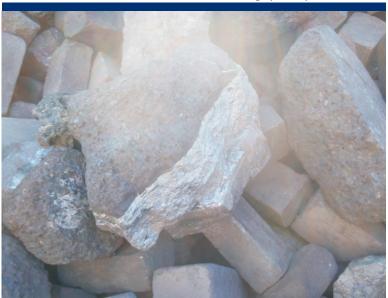


Photo 22 Material from bottom of furnace (silica and carbon).

Direction: South Date: 10/25/11 Time: 12:08

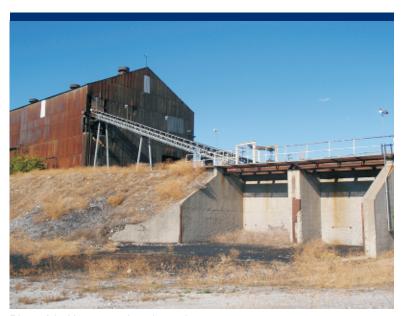


Photo 24 Hopper and scale equipment.

Direction: North Date: 10/25/11 Time: 12:17

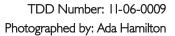




Photo 25 Berm.

Direction: South Date: 10/25/11 Time: 12:18



Photo 27 Furnace building.

Direction: South Date: 10/25/11 Time: 12:22



Photo 26 Stormwater collection.

Direction: North Date: 10/25/11 Time: 12:21



Photo 28 Hole where furnaces were.

Direction: South Date: 10/25/11 Time: 12:25

ROCK ISLAND SILICON PLANT Rock Island, Washington



Photo 29 Monitoring well near former QA/QC lab.

Direction: North Date: 10/25/11 Time: 12:30

TDD Number: 11-06-0009 Photographed by: Ada Hamilton



B Sample Plan Alteration Forms



SAMPLE PLAN ALTERATION FORM

Project Name and Number:			
Material to be Sampled:			
Measurement Parameters:			
Standard Procedure for Field Colle	ection and Laboratory Analysis (cite references)	:	
	200201 0110 2000 011001 01101 (0110 1010 10	•	
Reason for Change in Field Proced	ure or Analytical Variation:		
Variation from Field or Analytical	Procedure:		
Special Equipment, Materials, or P	Personnel Required:		
CONTACT	APPROVED SIGNATURE	DATE	
Initiator:	ATTROVED SIGNATURE	DATE	
START PL:			
EPA TM:			
EPA QA Manager:			





C Standard Operating Procedures



ecology and environment, inc.

STANDARD OPERATING PROCEDURE

BOREHOLE INSTALLATION AND SUBSURFACE SOIL SAMPLING METHODS

SOP NUMBER: GEO 4.7

REVISION DATE: 5/25/2012 SCHEDULED REVIEW DATE: 5/26/2017

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BOREHOLE INSTALLATION AND SUBSURFACE SOIL SAMPLING METHODS SOP: GEO 4.7 REVISION DATE: 5/25/2012

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1 Scope and Application

This Standard Operating Procedure (SOP) describes the procedures utilized by E & E for collection of unconsolidated and consolidated subsurface samples from boreholes using a subcontract driller. Most subsurface investigations require the drilling of boreholes for one or more purposes: collection of soil samples for lithologic logging and laboratory testing; lithologic and hydrogeologic characterization using borehole geophysical logging; and installation of piezometers or monitoring wells. Drilling methods are selected based on availability and cost; suitability for the type of geologic materials at a site (unconsolidated or consolidated); and potential effects on sample integrity (influence by drilling fluids and potential for crosscontamination between aquifers). Site-specific drilling methods and sampling procedures also vary depending on the data quality objectives (DQOs) identified in program/project planning documents.

Procedures for collecting soil samples for volatile organic compound (VOC) analyses are presented in the E & E VOC Soil and Sediment Sampling SOP ENV 25.

Procedures for collecting surface and shallow subsurface soil sampling SOP are presented in the E & E Borehole Installation Methods SOP ENV 3.13.

Procedures for sample handling are defined in E & E Environmental Sample Handling, Packaging and Shipping SOP ENV 3.16. Site-specific sample handling procedures are dependent on the project DQOs.

Procedures for equipment decontamination are defined in E & E Sampling Equipment Decontamination SOP ENV 3.15. Site-specific equipment decontamination procedures are dependent on the project DQOs.

This is intended for use by personnel who have knowledge, training and experience in the field soil sampling activities being conducted.

2 Definitions and Acronyms

DQO Data Quality Objective

E & E Ecology and Environment, Inc.

HSA hollow-stem auger

SHASP Site Specific Health and Safety Plan

SOP Standard Operating Procedure
VOC Volatile Organic Compound

3 Procedure Summary

A wide variety of drilling methods have been developed that could be suitable for one or more of the purposes described above. Table 1 summarizes information on drilling methods.

Table 1 Summary Information on Drilling Methods

Drill Method	Casing/ Open Hole	Can Drill Fluids Affect Groundwater Quality?	Core Samples?
Hollow-Stem Auger	Open Hole	No.	Possible
Direct-Push/Geoprobe®	Either	No	Yes
Open-Hole Rotary Methods			
Direct Air Rotary with Bit	Open Hole	Yes	Possible
Direct Air Rotary with Downhole Hammer	Open Hole	Yes	Possible
Direct Mud Rotary	Open Hole	Yes	Possible
Reverse Rotary (no casing)	Open Hole	Yes	Possible
Cable Tool	Either	No	Possible
Rotary Drill-Through Methods	•		
Rotary Casing Driver	Casing	Yes	Possible
Dual Rotary Advancement	Casing	Yes	Possible
Other Methods			
Reverse Dual Wall Rotary	Casing	Yes	Possible
Reverse Dual Wall Percussion	Casing	Yes	Possible
Hydraulic Percussion	Casing	Yes	Possible
Downhole Casing Advancers	Casing	Yes	Possible
Jet Percussion	Casing	Possible	Possible
Jetting	Open Hole	Possible	No
Solid-Stem Auger	Open Hole	No	Possible
Bucket Auger	Open Hole	No	Possible
Rotary Diamond	Open Hole	Possible	Yes
Directional Drilling	Either ^a	Possible	Possible ^b
Sonic Drilling	Either	Possible	Yes
Driven Wells	Either	No	No
Cone Penetration	Open Hole	No	Possible ^c

Notes:

Subsurface soil samples are collected from boreholes for chemical and physical analysis and to aid in the definition and tracking of contaminants in the soil. The subsurface soil samples may be either composite or discrete, and either disturbed or undisturbed. The type of sample to be collected depends on the drilling technique and the purpose of the investigation.

4 Cautions

Cautions associated with borehole installation include decontamination procedures, depth control, and health and safety associated with heavy equipment use. All equipment that is brought on site must be clean prior to arrival and all downhole equipment must be decontaminated prior to drilling each boring location. This is an important factor to ensure that off-site contaminants are not introduced to the soils (and groundwater) being collected and that contaminants encountered at one site location are not spread throughout the site.

Depth control is also an important factor to ensure that exact soil horizons, formations, and zones of contamination identified during sampling are accurately documented and will allow for accurate placement of well materials. The oversight geologist should be familiar with the drilling

^a EC rig uses casing advancement; other methods may involve open-hole advancement.

Sampling with a device resembling a split spoon may be possible with some directional rigs.

^c Geoprobe has developed a core sampler for use with a cone penetration testing rig.

methodology and independently verify measurements on a regular basis. This will identify any discrepancies between the oversight geologist and the drill rig operator.

As with any heavy equipment operation, proper personal protective equipment is essential. At a minimum, Level-D protection will be required for all drilling operations.

5 Equipment and Supplies

The equipment and supplies required for field work depend on the program/project DQOs. The following is a general list of equipment and supplies. A detailed list of equipment and supplies should be prepared based on the project planning documents. In general, the use of dedicated or disposal equipment is preferred but equipment may be re-used after thorough decontamination between sample locations (refer to E & E Sampling Equipment Decontamination SOP ENV 3.15).

- Stainless-steel or Teflon™ spoons, trowels, or scoops. Other construction material may be acceptable depending upon the program/project planning documents and DQOs
- Soil-coring equipment or augers acceptable depending upon the program/project planning documents and DQOs
- Sampler such as thin-walled tube sampler (e.g., shelby tube sampler), split-spoon sampler, continuous soil core sampler (e.g. Laskey), continuous-flight auger, or direct push soil corer (e.g., Macro-Core®).
- Stainless-steel mixing bowls. Other bowl construction material may be acceptable depending upon the program/project planning documents and DQOs
- Spade(s) and/or shovel(s)
- Liners and/or catchers for augers or core samplers as specified in the project planning documents
- Pipe cutter(s), stainless steel knives(s), or power saw to cut liners
- Survey stakes or flags to mark locations
- Ancillary equipment and supplies, e.g., meter stick or tape measure, aluminum foil, plastic sheeting, disposable gloves.

Supporting equipment and supplies also may be required to address the following:

- Field logbooks and supplies (Refer to project planning documents and the E & E Field Activity Logbooks SOP DOC 2.1 for details)
- Decontamination equipment and supplies (Refer to project planning documents and E & E Sampling Equipment Decontamination SOP ENV 3.15for details)
- Sample containers, preservatives, and shipping equipment and supplies (Refer to project planning documents and the E & E Environmental Sample Handling, Packaging and Shipping SOP ENV 3.16 for details)
- Waste handling supplies (Refer to project planning documents and E & E Handling Investigation-Derived Wastes SOP ENV 3.26 for details)

6 Procedure

The most accurate method for obtaining information on the characteristics of unconsolidated deposits is to collect representative samples of the soil at measured depths and at intervals that will provide a complete lithologic profile of the soils. E & E staff will use the following procedures for completing borehole installation and subsurface soil sampling:

- Review relevant project planning documents, e.g., work plan, sampling and analysis plan, quality assurance project plan, health and safety plan, etc.
- Select the sampling procedure(s) that meet project DQOs.
- Refer to the E & E Field Activity Logbooks SOP DOC 2.1 for guidance on the types of information that should be recorded for each sample.
- Refer to the E & E Environmental Sample Handling, Packaging and Shipping SOP ENV
 3.16 for guidance on how samples should be labeled, packaged, and shipped.

6.1 Subsurface Soil Sampling Methods

6.1.1 Disturbed and Undisturbed Overburden Samples

Soil samples from unconsolidated deposits can be collected as disturbed or undisturbed soil samples. Disturbed soil samples are produced by the action of the hollow-stem auger (HSA) and are called drill cuttings. The components of an HSA are shown in Figure 1. Disturbed samples are not representative of the formations penetrated because of the possible sorting and grinding of the cuttings while being carried to the surface. In general, disturbed samples do not contain detailed lithologic information, and the depth that the soil is encountered is less precise.

Mildly disturbed to relatively undisturbed soil samples are collected in a variety of sampling devices, including the split spoon or split-barrel sampler (see Figure 2), and the continuous soil core sampler (see Figure 3). Sonic drilling also provides relatively undisturbed samples. Undisturbed soil samples are collected using the thin-walled tube sampler (see Figure 4).

The collection of undisturbed samples ensures the preservation of detailed lithologic information (such as the degree of consolidation, sorting, bedding, etc.) and a more accurate estimation of sample depth.

6.1.2 Composite and Discrete Overburden Samples

Composite samples are prepared from aliquots of discrete samples. They are useful for obtaining a representative sample from a subsurface interval for analytical purposes. However, composite samples are inadequate for lithologic purposes.

Discrete samples are obtained from a specific depth and are useful when detailed analytical information about the overburden soils is required. Analysis of discrete overburden soil samples provides the more accurate information on the depth of contamination than composite samples.

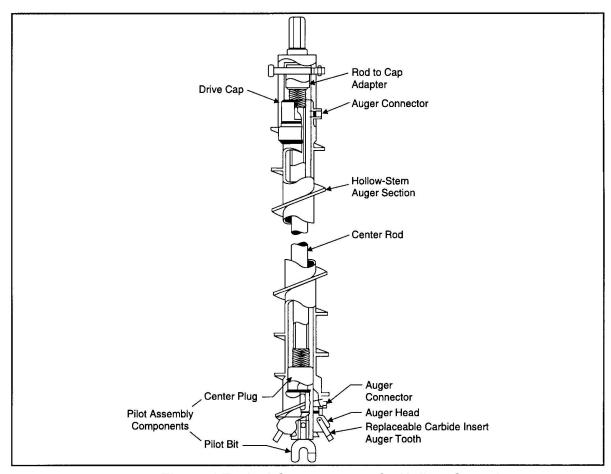


Figure 1 Typical Components of a Hollow-Stem Auger

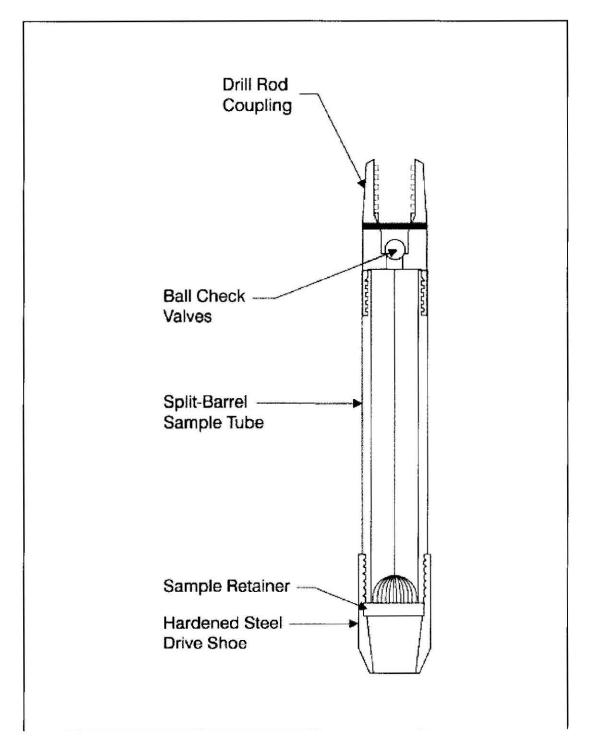


Figure 2 Split-Spoon or Split-Barrel Sampler

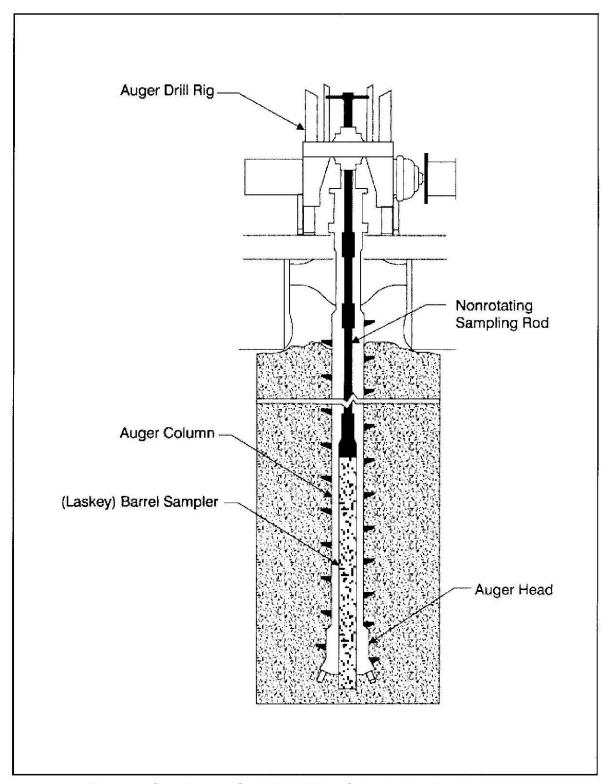


Figure 3 Continuous Sampling Tube System (Laskey)

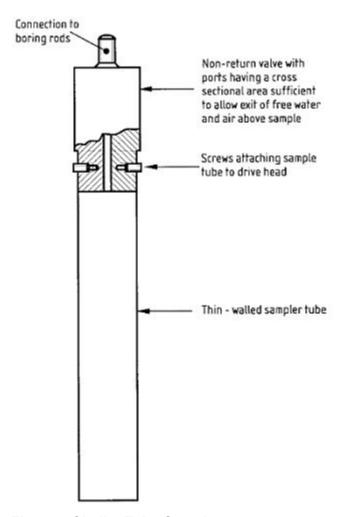


Figure 4 Shelby Tube Sampler

6.1.3 Environmental Sample Collection

Samples for environmental laboratory analysis can be collected from sampling devices described above and in Section 6.2.

- 1. Samplers should be decontaminated or dedicated for collection of environmental samples.
- 2. Samplers should be in a perpendicular position on the sample material.
- Sampling methods should attempt to minimize compression of the sample.
- 4. Record the length of the tube used to penetrate the material being sampled and the number of blows required to obtain this depth.
- 5. Once the sample is collected record all length of sample and estimate sample recovery and compression. Project planning documents may indicate acceptability criteria for samples recovery and sample collection. The geologist will need to determine based on site conditions if poor recovery is due to sampling equipment or the geologic formation. The goal is obtain a sample for environmental analysis that is representative of subsurface soil at a specified depth interval and meet the project DQOs. If samples don't meet the DQOs then determine a course of action with the project manager.

- Soil samples should be collection as soon as possible following extraction of the sampler.
 - o Place sampler or liner on clean surface
 - Carefully remove any end caps and/or catchers
 - Evaluate record core length, geologic information, monitoring data, and any visual observations.
 - For transverse sectioning of liners, beginning at the soil surface, measure and mark the sample sections on the outside of the liner
 - Cut the liner with a manual pipe cutter or core liner and core with a decontaminated saw blade into marked sections.
 - Extrude the soil from the cut segments of the liner. If necessary use a plunger cover with aluminum foil to aid in extruding the core.
 - Empty the core segment into a stainless steel bowl (or other type as specified in the project planning documents).
 - Record observations of the soil types.
 - Immediately collect volatile organic analyte and sulfide samples.
 - For longitudinal sectioning of cores, open the split spoon or use a knife to cut the liner and expose the upper half of the soil cylinder.
 - Beginning at the soil surface, measure and mark the sample sections using a tape measure set aside the core.
 - Record observations of the soil types.
 - Immediately collect volatile organic analyte and sulfide samples.
 - Scope the core segment into a stainless steel bowl (or other type as specified in the project planning documents).
 - o If multiple core segments are necessary to collect adequate sample volume, they should all be combined in the bowl prior to homogenization
 - Homogenize the sample as thoroughly as possible
 - Transfer sample aliquots to appropriate sample containers and preserve as required in the project planning documents.
- Return unused soil to the boring or containerize as specific in the project planning documents,
- 8. Follow proper procedures for sample handling and transportation to the laboratory for analysis.

6.1.4 Geotechnical Sample Collection

Some sampling devices also may be used to collect information for geotechnical analysis such as soil density. Geotechnical sampling should strictly follow standards for sampling based on the type of test performed. This information should be documented in the project planning documents. Detailed procedures are not included here because standards are routinely updated and only the most current standard should be used. Spilt spoon sampling work should be performed in accordance with American Society for Testing and Materials (ASTM) ASTM

D1586 - 11 Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils. If thin-wall tube sampling is used for soil collection, then follow ASTM D1587 - 08 Standard Practice for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes.

6.2 Borehole Installation

6.2.1 Inspection and Cleaning of Sampling Equipment

Proper cleaning of the drill rig, downhole equipment, and sampling equipment prior to arriving at the site and between drilling locations is necessary to minimize the potential introduction of contaminants into soil and groundwater samples. A rig should not be allowed to enter a site if the rig appears to be dirty (other than road dirt) from previous use at another site. While operating on site, the drill rig should be checked repeatedly for oil and hydraulic fluid leaks. These precautions are essential to ensure that trace contaminants from the drilling process are not introduced to the samples.

Before drilling begins at a site, and after each boring is completed, all the down-the-hole drill equipment, the rig, and other equipment (as necessary) should be steam cleaned, or cleaned using high-pressure hot water, and rinsed with pressurized potable water to minimize cross contamination. Special attention should be given to the threaded sections of the casings and drill rods. Additional cleaning may be necessary during the drilling of individual holes to minimize the carrying of contaminated materials from shallow to deeper strata by contaminated equipment (e.g., decontamination of split spoon samplers as associated drill rods).

Equipment with porous surfaces, such as rope, cloth hoses, and wooden blocks or tool handles cannot be thoroughly decontaminated. These should be disposed of properly at appropriate intervals. These intervals may be the duration of drilling at the site, between individual wells, or between stages of drilling a single well, depending upon characteristics of the tools, site contamination, and other considerations.

Cleaned equipment should not be handled with soiled gloves. Surgical gloves, new clean cotton work gloves, or other appropriate gloves should be used and disposed of when even slightly soiled. The use of new painted drill bits and tools should be avoided since paint chips can bias soil and groundwater samples.

Upon completion of drilling activities at a particular site, all drilling equipment should be steam cleaned or cleaned using high-pressure hot water to ensure that no contamination is transported off site.

6.2.2 Hollow-Stem Auger Drilling

An HSA column simultaneously rotates and axially advances using a mechanically or hydraulically powered drill rig. The hollow stem of the auger allows use of various methods for continuous or intermittent sampling of subsurface soils. Riser and screen for monitoring wells can be placed in the hollow stem when the desired depth has been reached, and filter pack and grouting emplaced as the auger is gradually withdrawn from the hole. Use of different diameter augers allows use of casings to isolate near-surface contamination and continuation of drilling with a smaller-diameter auger. HSA flights are manufactured in 5-foot lengths and have various inside diameters ranging from 2.25 inches to 10.25 inches.

If a split-barrel soil sampler is used to collect unconsolidated soil samples, a center plug of the same diameter as the HSAs and a section of drilling rod are placed inside the lead flight. The HSAs are advanced through the unconsolidated deposits to the first sampling interval, and the

center plug is then removed from the HSAs. A precleaned split-barrel soil sampler is attached to the end of the drilling rod and lowered into the HSAs. A safety hammer is attached to the top of the drilling rod, and the split-barrel soil sampler driven into the undisturbed soil to a depth of 2 feet. The split-barrel soil sampler is retrieved and opened to remove the soil sample. The center plug is replaced in the HSAs, and another flight of HSAs is attached to the top of the flight already in the ground. The process is repeated until bedrock is encountered or the project depth is reached.

A continuous soil core sampler (i.e., Laskey) is used to collect 5-foot continuous soil core samples while the HSAs are turning. The Laskey soil sampler is used instead of a center plug in 4.25-inch HSAs, and the head of the sampler leads the HSAs by 2 to 6 inches. At the completion of a 5-foot run of HSAs, the Laskey soil sampler is recovered and opened in a manner similar to a split-barrel sampler. Following sample collection and decontamination of the Laskey soil sampler, the sampler is replaced inside the HSAs, and another flight of HSAs is attached to the top of the flight already in the ground.

A Shelby tube sampler is used to collect undisturbed overburden soil samples in a manner similar to a split-barrel soil sampler. Once the HSAs have reached the top of the interval to be sampled, the drilling rods holding the center plug are withdrawn from the HSAs, the Shelby tube is attached to the end of the drilling rod, and the Shelby tube is lowered into the HSAs. The Shelby tube is pushed out the bottom of the HSAs to the prescribed depth, and the tube is retrieved. The Shelby tube is not opened in the field, but is shipped to the laboratory. The process is repeated until bedrock is encountered or the project depth is reached.

6.2.3 Direct-Push/Geoprobe

Installation of boreholes using direct-push/Geoprobe® methods utilizes a hydraulically powered machine to drive rods into the subsurface with both static (downward push) and percussive (hammer) force. Rod widths generally vary from 1.25 inches to 4.25 inches in diameter. This method can be used for continuous or discrete soil sampling in unconsolidated formations only. This method of borehole installation is effective for achieving depths up to 60 feet below ground surface or less, although newer more powerful machines have recently been constructed that have achieved depths in excess of 200 feet below ground surface in certain formations (e.g., 8000 Series Geoprobe®).

There are two soil sampling methods commonly used, macro-core and dual tube. The macro-core sampler does not incorporate the use of casing and utilizes a center rod to hold the core barrel tip in place until the desired depth is reached. The center rod is removed at the desired depth so that soils are allowed to enter the core barrel while it is further driven into the subsurface. The entire assembly is removed to retrieve the soil core and the borehole may collapse at this time. Because the borehole can collapse in between sampling, there are some concerns with slough and cross contamination using this method. A plastic sleeve lines the length of the macro-core barrel to contain the soils and is used to remove the soils. The plastic sleeve should be replaced with a new sleeve for each soil core. This method can be used for continuous or discrete sampling and typically uses a 2.25-inch core barrel and yields a 1.25-inch soil core (other sizes available).

Dual-tube soil sampling utilizes one set of rods that are advanced as an outer casing. A set of inner rods are used to hold a 4- or 5-foot plastic sleeve in the tip of the casing/rod. After each 4- or 5-foot increment, the plastic sleeve is removed using the inner rods and replaced with a new liner before advancing further. Borehole advancement only continues when the soil core barrel is placed back into the borehole and mated with the leading rod of the casing. This method is generally used for continuous soil sampling although it can be utilized for discrete sampling

using a center rod. The typical diameter of tooling using this set up is 4.25-inche casing with a 3-inch soil core. Because the casing remains in place, this method is effective for use in saturated formations and areas where cross contamination is of concern. Given the greater diameter of the tooling, this method typically is more limited in depths of penetration (Geoprobe® 2006).

6.2.4 Direct Mud Rotary

Direct mud rotary bore hole drilling is advanced through rapid rotation of a drill bit (Tri-cone) mounted upon the end of drill rods. The bit cuts and breaks the material at the bottom of the hole into small pieces (cuttings). The cuttings are removed by pumping drilling fluid (water, or water mixed with bentonite or other fluid enhancers) down through the drill rods and bit and up the annulus between the bore hole and the drill rods. The fluid is referred to as drilling mud. Drilling mud is recirculated through the use of a "mud tub" where cuttings are accumulated and drilling mud is pumped back down the drilling rods. The drilling fluid also serves to cool the drill bit and stabilize the bore-hole walls, to prevent the flow of fluids between the bore hole and surrounding earth materials, and to reduce cross contamination between aquifers. Direct mud rotary drilling offers a number of advantages; it is a fast and efficient means of drilling. Efficient rigs can produce several hundred feet of hole per day. The direct mud rotary method can reach to several thousand feet in depth and create hole diameters to greater than 48 inches. The method is adaptable to a wide range of geologic conditions. Only exceptionally large, poorly stabilized boulders, or karst (cavernous) conditions are unsuited for direct mud rotary drilling. Direct mud rotary rigs are widely available throughout the United States. Sediment sampling is broadly supported in direct mud rotary drilling; standard split-barrel and thin-wall sampling are available in poorly lithified materials while a broad range of coring apparatus' are supported for consolidated rock. Hydrologic conditions have little effect upon direct mud rotary drilling; operations are usually unhindered by the presence of ground water. Direct mud rotary drilling readily supports the telescoping of casings to successively smaller sizes to isolate drilled intervals and to protect lower geologic units from contamination by previously drilled, contaminated upper sediments.

The use of direct mud rotary drilling requires careful management of drilling fluids to prevent the buildup of drilling mud (mud cake) in permeable intervals, which can impact the quality of water samples collected from the monitoring well and inhibit flow to the well. A pH neutral bentonite should be used to prevent interference with water quality samples. Additionally, care has to be taken to ensure that organic compounds sometimes added to drilling fluids do not interfere with chemical analysis of water samples. To prevent this, drilling muds will only contain chemically inert substances and the use of petroleum products for fittings and pipe joints will be prohibited. Substitutes for petroleum grease such as vegetable-based oil and lubricants will be utilized.

Direct mud rotary drilling may sometimes be the best available alternative, especially for deep wells or wells completed into well lithified rocks. When direct mud rotary methods are used, hole diameters should be 3 to 5 inches larger than the outer diameter of the well casings to allow effective placement of filter and sealing materials. Two-inch diameter monitoring wells should therefore be installed within 5.5-inch diameter or larger holes.

6.2.5 Direct Air Rotary and Downhole Hammer

The basic rig setup for air rotary with a tri-cone or roller-cone bit is similar to direct mud rotary, except that the circulation medium is air rather than water or mud. Compressed air is circulated down through the drill rods to cool the bit and carry cuttings up the hole to the surface. A cyclone separator slows the air velocity and allows the cuttings to fall into a container. A down-

the-hole hammer, which operates with a pounding action as it rotates, replaces the roller-cone bit.

6.2.6 Sonic Drilling

The sonic drill rig is similar to other drilling rigs in that it is a machine attached to a frame mounted on some type of vehicle. Sonic drilling is the application of high frequency vibration used in conjunction with down pressure and rotation to advance drilling tools through subsurface formations (see Figure 5). The use of high frequency vibration through the drilling tools causes the formation materials to vibrate at their natural frequencies allowing the drilling tool (casing) to advance by fracturing, shearing, or displacing formation material. Most sonic drilling is utilized for drilling in unconsolidated material. However, sonic drilling can also be used for drilling and sampling of rock formations.

During drilling, unconsolidated samples are collected using a sample (or core) barrel. Core barrels are either solid tubes or split barrels of various diameters and lengths generally sized to match the inside diameter of the drill casing being utilized. Typical core barrels are 10 to 20 feet in length and casing sizes range from 0.5 inches to 12 inches, although 4- to 6-inch casing is typical. The core barrel is fitted with a drill bit/cutting shoe, and the sampler is placed within the outer casing material and attached to the rig by drilling rods. As the borehole is advanced, formation material is collected within the core barrel.

Following the sampling run (typically 10 to 20 feet), the core barrel is extracted from the well casing. Formation material is then extracted from the core barrel. Typically, sample material is extracted into a plastic sleeve, which is separated into convenient lengths for logging. The process of sonic drilling and sample collection will cause the sample to be distorted due to vibration, but generally will be intact. In the case of rock drilling, the vibration may create mechanical fractures that can affect the structural analysis for permeability and thereby not reflect the true *in-situ* condition.

The advantages to using sonic drilling technology include reducing the amount of drill cutting generated, providing rapid formation penetration, and the recovery of a continuous core sample.

6.3 Borehole Abandonment

Borehole abandonment is necessary to eliminate potential physical hazards, prevent groundwater contamination, conserve aquifer yield and hydrostatic head, and prevent intermixing of surface water and subsurface water. After the necessary unconsolidated soil samples or consolidated core samples have been collected from the borehole, the HSAs are removed from the borehole and the HSA flights cleaned. A cement/bentonite grout should be tremied into the borehole to the surface. The grout should consist of potable water, bentonite powder, and Type I Portland cement, with 94 pounds of cement and 5 pounds of bentonite per 6.5 gallons of water.

Always determine whether there are applicable regulatory or programmatic specific borehole abandonment procedures or reporting requirements.

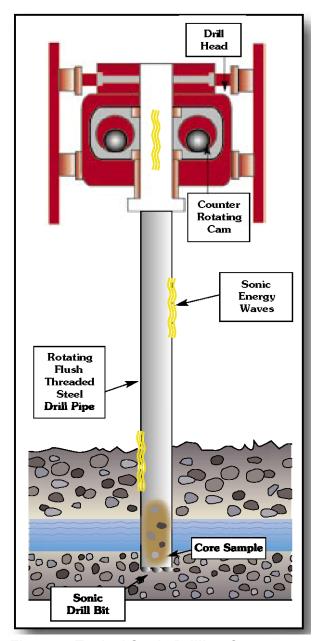


Figure 5 Typical Sonic Drilling Components

7 Quality Assurance/Quality Control

Prior to initiating field work, the project planning documents (e.g., work plan, sampling and analysis plan, quality assurance project plan, SHASP, *et al*) should be reviewed by field personnel to identify sampling procedure(s) that will most likely provide surface and shallow subsurface soil samples that meet project DQOs.

The program/project manager should identify personnel for the field team who have knowledge, training and experience in the borehole installation and subsurface soil sampling activities being conducted typically trained geologist. The geologist should document all borehole sampling and lithological information in E & E's geotechnical logbook. All project personnel, if necessary,

can complete ancillary procedures, e.g., field logbook documentation, equipment decontamination, sample shipment, and waste disposal.

The lead geologist should prepare a detailed equipment checklist before entering the field and verify that sufficient and appropriate equipment and supplies are taken into the field.

Quality assurance/quality control samples (e.g., co-located samples) are collected according to the site quality assurance project plan. Field duplicates are collected from one location and treated as separate samples. Field duplicates are typically collected after the samples have been homogenized. Collocated samples are generally collected from nearby locations and are collected as completely separate samples. Rinsate blanks may be necessary to evaluate the effectiveness of field decontamination procedures (see E & E SOP Env 3.15).

In cases where multiple hand-collected scoop, auger or core samples are required to generate an adequate sample volume, homogenization is important. Field personnel should collect sample aliquots only after mixing has produced soil with textural and color homogeneity.

At sites with known or suspected contamination, samples should be collected moving from least to most contaminated areas.

8 Health and Safety

Prior to entering the field, all field personnel formally acknowledge that they have read and understand the project specific health and safety plan.

Augers and soil core sampling apparatus are inherently dangerous pieces of heavy equipment which a high "pinch" potential. Care should be taken at all times when handling such equipment, not just during sample collection.

Prior to any subsurface work, verify that underground utilities have been located and marked.

9 Special Project Requirements

Project or program-specific requirements that modify this procedure should be entered in this section and included with the project planning documents.

10 References

See E & E SOP Env 3.13 for additional sources of technical information on soil sampling.

Geoprobe®. 2006. Geoprobe® DT 325 Dual Tube Sampling System, Technical Bulletin NO. MK 3138, revised 1/2011.

END OF SOP

ecology and environment, inc.

STANDARD OPERATING PROCEDURE

FIELD ACTIVITY LOGBOOKS

SOP NUMBER: DOC 2.1

REVISION DATE: 8/24/2012 SCHEDULED REVIEW DATE: 5/25/2017

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8	Special Project Requirements7
9	References

1 Scope and Application

Proper documentation of field activities is a critical component of any field effort. This Standard Operating Procedure (SOP) establishes procedures for initiating, entering information/data into, reviewing, and maintaining/storing hard copy field logbooks for E & E field activities. Field activities may range from simple reconnaissance to complex sampling programs and may include: visual or other observations, in situ or ex situ field measurements (monitoring), or sample collection, and can include meetings with E & E clients, sub-contractors or other stakeholders.

Field logbook documentation may be supplemented by other records (e.g., site safety forms, data collection forms, electronic data, or geotechnical logbooks). Information and data to be recorded on such forms or logbooks are addressed in the applicable SOPs.

Field observations, measurements, and samples have value to data users only to the degree that the observation, measurement, or sample is representative of a specified environment, setting, or process. Field logbooks address representativeness by documenting the following:

- Identification of the subject of the observation, measurement, or sampling;
- Selection of an observation, measurement, or sampling location and time that represents that subject;
- Compliance with or deviation from the work plan, sampling and analysis plan, quality assurance project plan, or other project or program plans; and

Sufficient documentation of how the observation, measurement, or sample represents the same subject as other observations, measurements, or samples from the vicinity. Complete and accurate logbook entries are important for several reasons: to ensure that data collection associated with field activities is sufficient to support the successful completion of the project; to provide sufficient information so that someone not associated with the project can independently reconstruct the field activities at a later date; to maintain quality control throughout the project; to document changes to or deviations from the work plan; to fulfill administrative needs of the project; and to support potential legal proceedings associated with a specific project. This Field Activity Logbook SOP is intended for use by personnel who have knowledge, training and experience in the field activities being conducted.

2 Definitions and Acronyms

Field Locations (sites) outside the controlled environment of an office or

laboratory.

Field Observation The qualitative and/or quantitative remarks/statements regarding sensory

inputs noted in the field.

Field Measurement The quantitative determination of physical, chemical, biological, geological

or radiological properties of a matrix by measurements made in the field.

Field Sampling The process of obtaining a representative portion of an environmental

matrix suitable for laboratory or field measurement or analysis.

E & E Ecology and Environment, Inc.

EPA Environmental Protection Agency

ID Identification

IDW – Investigation-derived waste

QA Quality assurance

QC Quality control

SOP Standard operating procedure

3 Procedure Summary

Prior to field activity, the program/project manager identifies field personnel; designates a field team leader; and team members responsible for documenting field activities. Since there may be multiple activities with unique logbooks, there may be multiple team members responsible for documenting field activities.

Prior to entering the field, the individual responsible for documenting field activities or other designated author should briefly summarize the field activities that will be conducted in the logbook.

Visual or other observations, in situ or ex situ field measurements (including instrument/equipment calibrations), or sample collection information should be recorded in real-time as field work is conducted. Meetings, including electronic communications, with E & E, clients, sub-contractors or regulatory personnel should be recorded. Compliance with or deviation from the work plan, sampling and analysis plan, quality assurance project plan, or other project or program plans should be highlighted together with authorization for such deviations.

The field team leader should review log book entries on a daily basis or more frequently, if appropriate. The project/program manager should review the logbooks at the close of fieldwork or more frequently for long-term field events. Logbooks may be audited by quality assurance personnel from E & E or a client.

The program/project manager is responsible for storing/archiving applicable logbooks in the project file.

4 Cautions

Logbook entry must be a priority and not left to "later." Contemporaneous documentation is critical to accurate and precise reporting.

Field logbooks become part of the permanent record for projects/programs and, thus, should include factual material, not opinions. Language used in logbooks should be objective and factual. Pertinent personal observations may be included, but must be clearly identified as such.

If multiple logbooks are used, a project logbook should be used to maintain control of all other logbooks.

Do not leave blank line(s) between logbook entries. Cross out blank spaces with a single line, initial and date the cross out.

Initials should not be used in place of signatures unless specifically allowed by client requirements. Logbooks are considered evidentiary files and full signatures are required under

judicial review guidelines (See EPA NEIC Policy 1991). If initials are used, a table of signatures and initials for all project personnel should be added in the front of the logbook.

5 Equipment and Supplies

Logbooks must be bound with consecutively numbered pages.

Entries should be made using indelible ink (preferably black).

6 Procedure

The following guidelines are used for completing Field Activity Logbooks:

- Logbooks will be assigned by the program/project manager to the field team leader.
 Additional logbooks may be assigned to other personnel (e.g., health and safety monitors). The program/project manager is responsible for tracking field event logbooks.
- A separate field logbook must be maintained for each project.
- Logbooks must be bound and contain consecutively numbered pages.
- The first entry for each day will be made on a new, previously blank page.
- No pages may be removed for any reason, even if mutilated or illegible. If a page or portion of a page is accidentally skipped during fieldwork, it should be crossed out, signed, and dated.
- Entries should be made in chronological order. Observations that cannot be recorded during field activities should be recorded as soon as possible. If logbook entries are made after field activities, the time of the activity/observation and the time that it is recorded should be noted.
- The time of each entry should be noted. It is customary to record time using a 24-hour clock.
- If corrections are necessary, they must be made by drawing a **single line** through the original entry in such a manner that it can still be read. Do not erase or render an incorrect notation illegible. The corrected entry should be written beside the incorrect entry, and the correction **initialed** and **dated**. Corrected errors may require a footnote explaining the correction.
- Logbooks should be signed at the end of each day (if more than one person makes entries into the logbook, each person should sign and date next to his or her entries).
 Signatures should be written along a single diagonal line drawn across the blank portion of the page following the last entry of the day.
- If multiple personnel are making entries in a logbook, then a table of personnel, signatures and initials should be added to the front of the logbook.
- At the completion of the field activity, the logbook must be returned to the project manager to include with the project files.

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6.1 Format

The following guidelines provide a general format and required information for all routine field activities using the Field Activity Logbooks:

- Title Page
 - The logbook title page should contain the following items:
 - Site name;
 - Site identification (ID) number; if applicable;
 - Location;
 - o Project Number;
 - Start/finish date; and
 - Book of . (may be completed at the end of the project)
- First Page
 - The following items should appear on the first page of the logbook prior to daily field activity entries:
 - Project Number;
 - Date:
 - Summary of proposed work (reference work plan and contract documents, as appropriate);
 - Weather conditions;
 - Team members and duties;
 - Health and safety discussion, topics, and attendees;
 - o Time work began and time of arrival (using 24-hour clock notation); and
 - Arrival/departure times of each field team member and other personnel if different from overall work times.

Successive Pages

- In addition to specific activity entries and observations, the following items should appear on every logbook page:
- Date at the top of each page,
- Project Number and site name,
- o Weather conditions if changed from the first entry of the data,
- Signature and date at the bottom of each page (if more than one person makes entries into the logbook, each person should sign and date next to his or her entries);
 and
- Strikethroughs of any unused lines. If more than one person makes entries into the logbook, each person should sign and date next to his or her entry.

- Last Page
 - The last page of the logbook may contain a brief paragraph that summarizes the work that was completed in the field and recorded in this logbook.
 - The last page should indicate if work is continuing in subsequent logbooks or if the project is complete.

6.2 Logbook Information

Field logbook entries will contain a variety of information based on the field activities being conducted (e.g., observing, monitoring, or sampling). The specific type of information recorded in the logbook will depend on the project requirements. In general, information recorded on field forms or electronic data do not need to be recorded in the logbook.

- If not field sampling map is available then a site sketch should be included and updated
 as necessary identifying the site layout, features and points of interest. A north arrow
 and rough scale should be included,
- A sketch of individual sampling locations if GPS coordinates are not collected,
- GPS locations, as applicable, for site features,
- Physical description of the site as observed during sample collection,
- Weather conditions, updated as necessary,
- Record of phone calls and/or other contacts with individuals at the site; including names and affiliations,
- Daily brief summary of the site safety meeting if not recorded on separate form,
- Daily brief outline of field activities to be performed that day,
- Pertinent field observations and any unique method to gather observations,
- Documentation of photographs, including:
 - Make and model of the camera(s),
 - Description of the photograph including the date and time,
 - Photograph number,
 - Direction or view angle of the photograph,
 - Name of the photographer(s),
- Brief description of monitoring procedures,
- Model and serial numbers of monitoring equipment,
 - Equipment preparation/calibration procedures, date and time, and results if not recorded on separate form,
 - Field maintenance and/or repairs,
- Sample collection procedures and reference to applicable work plan section or SOP,

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- Sample collection activities, including:
 - Pre-sampling activities (e.g., well purging and the number of volumes purged before sample collection),
 - Data associated with pre-sampling activities (e.g., well purging pH, conductivity, temperature data),
 - Equipment decontamination procedure,
- Sample information and observations
 - Sample number, station location ID, programmatic ID, and/or location, including relationship to permanent reference point(s),
 - Name(s) of sampler(s),
 - Sample description, sample depth interval, sample time, sample date, and any field screening results,
 - Sample matrix and number of aliquots if the sample is a composite,
 - Container and preservatives used, recipient laboratory including contact information, and requested analyses, and
 - Any preservative added in the field including preservative type, lot number and expiration date.
- Quality assurance (QA)/quality control(QC) samples,
 - o For trip blanks indicate the source of the blanks,
 - For equipment rinsate samples, the equipment from which the rinsate sample is collected should be noted and source of the DI water, and
 - Field duplicates or replicates and a description of how the duplicate was subsampled.
- Shipping paper (airbill) numbers, chain-of-custody form numbers.

6.3 Work Plan Changes/Deviation

Compliance with or deviation from the work plan, sampling and analysis plan, quality assurance project plan, or other project or program plans should be highlighted together with authorization for any deviations. Deviations (who, what, where, when, why, and how) from the plans and the circumstances necessitating such changes should be recorded.

6.4 Investigation-Derived Waste

Disposition of non-hazardous versus potentially hazardous IDW should be delineated in the field planning documents. The following information should be included in the logbook:

- Nature and disposition of non-hazardous wastes;
- The type and number of containers of potentially hazardous IDW generated (each "drum" should be numbered and its contents noted);
- Information relevant to characterizing IDW;
- Disposition of IDW (left on site or removed from site); and

- IDW sample information should be recorded the same as other samples.
- The type of paperwork that accompanied the waste/sample shipment (e.g., manifests).

6.5 Data Collection Forms

Certain phases of fieldwork may require the use of separate project-specific data collection forms, such as sample collection, equipment calibration or daily summary forms. Use of such forms and the types of information recorded should be noted in logbook. Information recorded on data entry forms does not need to be repeated in the logbook.

7 Quality Assurance/Quality Control

Compliance with or deviation from work plan, sampling and analysis plan, quality assurance project plan, or other project or program plans should be highlighted together with authorization for any deviations.

Prior to field activity, among other responsibilities, the program/project manager should identify knowledgeable, trained, and experienced field personnel; designate a field team leader; and an individual responsible for documenting field activities. Since there may be multiple activities with unique logbooks, there may be multiple individuals responsible for documenting field activities.

Prior to entering the field, the individual responsible for documenting field activities or other designated author should briefly summarize the field activities being conducted in the logbook.

The field team leader should review log book entries on a daily basis or more frequently if appropriate. The project/program manager should review the logbooks at the close of fieldwork or more frequently for long-term field events. Logbooks may be audited by quality assurance personnel from E & E or a client.

The project/program manager is responsible for storing/archiving applicable logbooks in the project file.

8 Special Project Requirements

Project or program-specific requirements that modify this procedure should be entered in this section and included with the project planning documents.

9 References

The following list sources of technical information on field logbooks.

United States Environmental Protection Agency (EPA). 1988. Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA Interim Final, U.S. EPA, EPA/540/G-89/004, October 1988

_____. 1991. Guidance for Performing Preliminary Assessments Under CERCLA, U.S. EPA, EPA/540/G-91/013, September 1991

______. 1991. *NEIC Policies and Procedures Manual*, U.S. EPA, EPA 33019-78-001-R, August 1991

_____. 1992. Guidance for Performing Site Inspections Under CERCLA, Interim Final, U.S. EPA, EPA/540/R-92-021, September 1992

Minor Revision Date	Revision Notes
	Added minor clarifications on signatures to address field audit findings.

END OF SOP



Title:	GEOLOGIC LOGGING
Category:	GEO 4.8
Revised:	March 1998

GEOLOGIC LOGGING

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1. Introduction

Geologic logging involves keeping detailed records during the drilling of boreholes, the installation of monitoring wells, and the excavation of test pits, and entering the geologic descriptions of the soil and rock samples recovered on a standardized form. E & E has adapted a standardized geotechnical logbook (see DOC 2.4 in E & E's Standard Operating Procedures [SOPs]) that contains items deemed important to record when installing monitoring wells, piezometers, and/or soil borings. This document discusses general procedures for completing geologic logs.

2. Drilling Logs

2.1 Basic Documentation

When drilling boreholes, the project geologist should maintain a log that describes each borehole. The E & E Geotechnical Logbook contains records for boreholes. The following basic information should be entered on the heading of each drilling log sheet (see Figure 1):

- Borehole/well number;
- Project name;
- Site location;
- Dates and times that drilling was started and completed;
- Drilling company;
- E & E geologist's name;
- Drill rig type used to drill the borehole;
- Drilling method(s) used to drill the borehole;



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Proj	ect Name				ſ	Water Level (TOIC)					
Site	Site Location					Date		Time		Level (Fee	et)
Date	e Started/F	inished _									
Drill	ing Compa	any									
						Well Lo	cation Sket	ch			•
Geo	ologist's Sig	gnature									
Rig	Type(s) —										
					1						
Drill	ing Method	d(s)									
Drill Bit S	ing Method Size(s) —	d(s))							
Drill Bit S Aug	ing Method Size(s) — per/Split Sp	d(s)	Auger Size(s)							And the state of t
Drill Bit S Aug Tota	ing Method Size(s) — per/Split Sp al Depth of	ocon Refusi	_ Auger Size(s)							The second secon

Depth (Feet) Sample Blows on Sampler CL SI S GR Pile Penetration Pile Penetration Rumber Recovery RQD Fracture Sketch (ppm) Comments (ppm) Comments Rum Times Number Recovery RQD Fracture Sketch (ppm) Comments (ppm) Comments Rum Times Number Recovery RQD Fracture Sketch (ppm) Comments (ppm) Comments Rum Times Number Recovery RQD Fracture Sketch (ppm) Comments (ppm) Comments Rum Times Number Recovery RQD Fracture Sketch (ppm) Comments (ppm) Comments Rum Times Number Recovery RQD Fracture Sketch (ppm) Comments (ppm) Comments Rum Times Number Recovery RQD Fracture Sketch (ppm) Comments (ppm) Comments Rum Times Number Recovery RQD Fracture Sketch (ppm) Comments (ppm) Comments Rum Times Number Recovery RQD Fracture Sketch (ppm) Comments Rum Times Number Recovery RQD Fracture Sketch (ppm) Comments Rum Times Number Recovery RQD Fracture Sketch (ppm) Comments Rum Times Number Recovery RQD Fracture Sketch (ppm) Comments Rum Times Number Recovery RQD Fracture Sketch (ppm) Comments Rum Times Number Recovery RQD Fracture Sketch (ppm) Comments Rum Times Number Recovery RQD Fracture Sketch (ppm) Comments Rum Times Rum Times

Figure 1 Drilling Log





- Bit and auger size(s);
- Depth of auger/split barrel sampler refusal;
- Total depth of borehole;
- Total depth of corehole (if applicable);
- Water level at time of completion measured from top of inside casing (TOIC); and
- A well location sketch.

2.2 Technical Information

During the drilling of a borehole, specific technical information about the unconsolidated material and rock encountered should be recorded on the drilling log sheet. The following minimum technical information should be recorded:

- Depth that sample was collected or encountered;
- Sample number assigned (if applicable);
- The number of blow counts required to drive the split barrel sampler 2 feet at 6-inch intervals (see Table 1);
- Description of soil components (see Figure 2);
- Description of rock profile (see Figure 3);
- Rock qualitative designation (RQD) (see Figure 4);
- Rock penetration time;
- Core run number (if applicable) and percent recovery; and
- Organic vapor readings in the sample.





Table 1 Standard Penetration Test for Soil Density

N-Blows/Feet	Relative Density
Cohesionless Soils	
0 - 4	Very loose
4 - 10	Loose
10 - 30	Medium
30 - 50	Dense
50	Very dense
Cohesive Soils	
2	Very soft
2 - 4	Soft
4 - 8	Medium
8 - 15	Stiff
15 - 30	Very stiff
30	Hard

3. Soil Classification

Soils should be described using the Unified Soil Classification System (USCS) in the narrative lithologic description section of Figure 5. Figure 6 is a summary of the American Society for Testing and Materials (ASTM) criteria for describing soils. Soil descriptions should be concise, stressing major constituents and characteristics, and should be given in a consistent order and format. The following order is recommended by the ASTM:

- 1. Soil name. The basic name of the predominant constituent and a single-word modifier indicating the major subordinate constituent.
- 2. Gradation or Plasticity. Granular soils (i.e., sands or gravels) should be described as well-graded, poorly-graded, uniform, or gap-graded, depending on the gradation of the minus 3-inch fraction. Cohesive soils (i.e., silts and clays) should be described as nonplastic, slightly plastic, moderately plastic, or highly plastic, depending on results of the manual evaluation for plasticity.
- 3. Particle size distribution. An estimate of the percentage and grain-size range of each subordinate constituent of the soil. This description may also include a description of angularity (see Figure 7).
- 4. Color. The basic color of the soil.





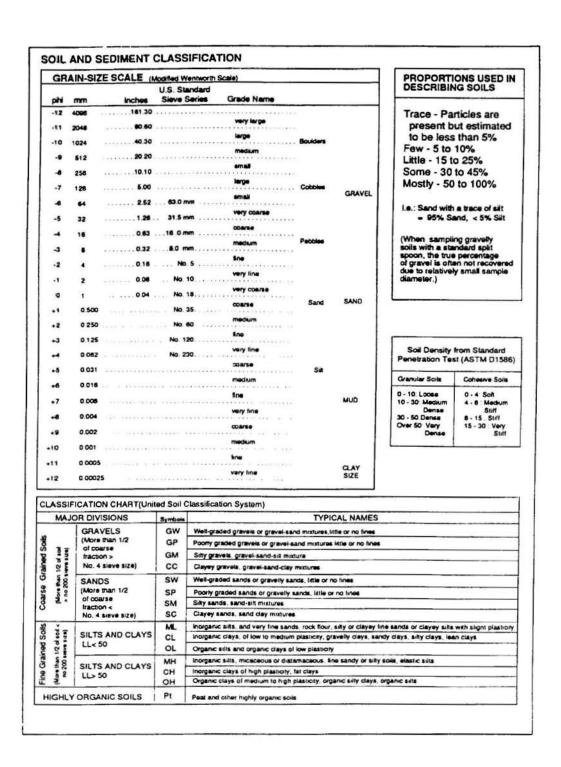


Figure 2 USCS Soil Classification Chart





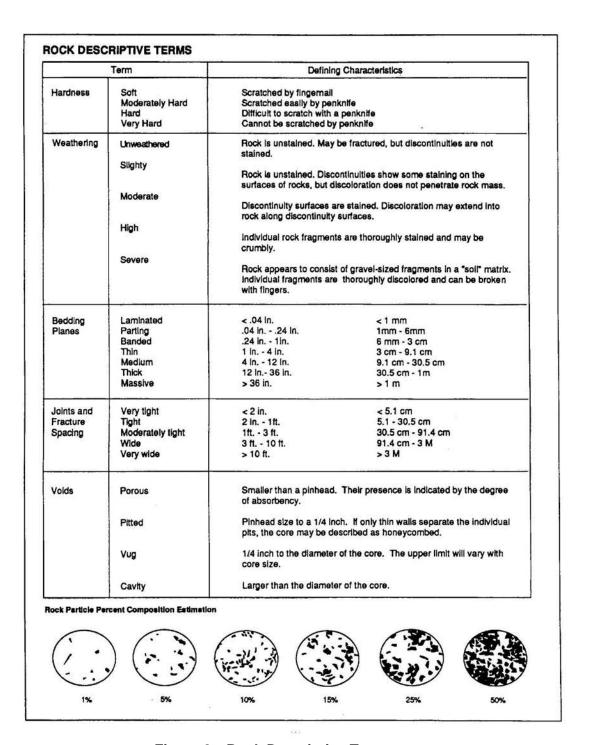


Figure 3 Rock Descriptive Terms



ROCK QUALITY DESIGNATION (RQD) AND FRACTURE FREQUENCY

Core borings are a useful means of obtaining information about the quality of rock mass. The recoverable core indicates the character of the intact rock and the number and character of the natural discontinuities.

Another quantitative index that has proved useful in logging NX core is a rock quality designation (RQD) developed by Deere (1963). The RQD is a modified core recovery percentage in which all the pieces of sound NX core over 4 inches long are counted as recovery. The length of the core run is the distance to the nearest tenth of a lost from the corrected depth of the hole at the end of the previous run to the corrected depth of the hole at the end of subject run. The smaller pieces are considered to be due to close shearing, jointing, fautting, or weathering in the rock mess and are not counted. The RQD is a more general measure of the core quality than the tracture frequency. Core loss, weathered and soft zones, as well as fractures, are accounted for in this determination. The RQD provides a preliminary estimate of the variation of the in situ rock mass properties from the properties of the "sound" portion of the rock core. Thus, a general estimate of the behavior of the rock mass can be made. An RQD approaching 100 percent denotes an excellent quality rock mass with properties similar to that of an intact specimen. RQD values ranging from 0 to 50 percent are indicative of a poor quality rock mass having a small fraction of the strength and stiffness measured for an intact specimen.

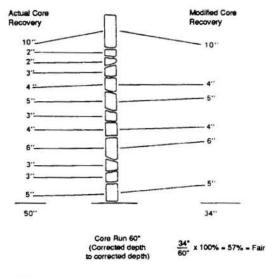
RQD (Rock Quality Designation)

0 - 25 Very Poor 25 - 50 Poor 50 - 75 Fair 75 - 90 Good 90 - 100 Excellent An example of determining the RQD from a core run of 60 inches measured from corrected depth to corrected depth is given in Diagram 1. For this particular case, the core recovery was 50 inches and the modified core recovery was 34 inches. This yields an RQD of 57 percent, classifying the rock mass in the fair category.

Problems arise in the use of RQD for determining the in situ rock mass quality. The RQD evaluates fractures in the core caused by the drilling process, as well as in natural fractures previously existing in the rock mass. For example, when the core hole penetrates a fault zone or a joint, additional breaks may form that, atthough not natural fractures, are caused by natural planes of weakness existing in the rock mass. These fresh breaks occur during drilling and handling of the core and are not related to the quality of the rock mass. The skill of the driller will affect the amount of breakage and the core loss that occurs. Poor drilling techniques will "penalize" the rock by lowering its apparent quality. It is difficult to distinguish between drilling breaks and those natural and incipient fractures that reflect the quality of the rock mass. In obtain instances, it may be advisable to include all fractures when estimating RQD. Obviously, some judgement is involved in core logging.

Another problem with the use of the RQD index is that the determinations are not sensative to the tightness of the individual joints, whereas in some instances, the in <u>situ</u> deformation modulus may be strongly affected by the average joint opening.

RQD OF A SINGLE CORE RUN.

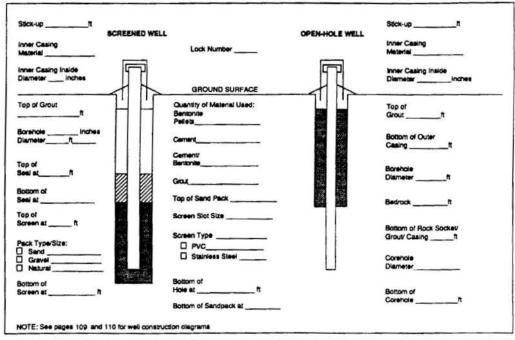


^{*} Typical calculation of RQD of a single core run. Note that the run is calculated from corrected depth to corrected depth.

Figure 4 Rock Qualitative Designation (RQD)







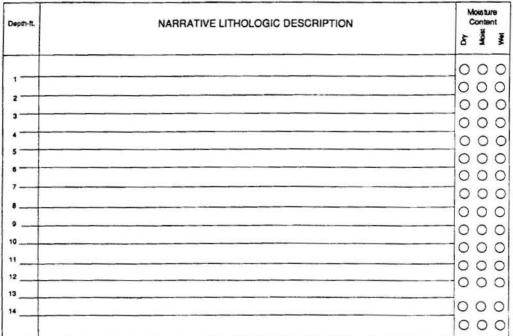


Figure 5 Narrative Lithologic Description





	Describing Angularity of Coarse-	Criteria for D	escribing Dry Strength
Grained Part		Description	Criteria
Description Angular	Particles have sharp edges and relatively plane side with unpolished surfaces	None	The dry specimen crumbles into powder with mere pressure of handling
Subangular	Particles are similar to angular description but have rounded	Low	The dry specimen crumbles into powder with some finger pressure
Subrounded	edges Particles have nearly plane sides but have well-rounded comers and	Medium	The dry specimen breaks into pieces or crumbles with considerable finger pressure
Rounded	edges Particles have smoothly curved	High	The dry specimen cannot be broken with finger pressure. Specimen will
nounded	side and no edges		break into pieces between thumb and a hard surface.
Criteria for I	Describing Dilatancy	Very High	The dry specimen cannot be broken between the thumb and shard surface
Description	Criteria		
None	No visible change in the specimen.	Criteria for D	Describing Structure
Slow	Water appears slowly on the	Description	Criteria
	surface of the specimen during shaking and does not disappear or disappears slowly upon squeezing.	Stratified	Alternating layers of varing material or color with layers at least 6 mm thick; note thickness.
Rapid	Water appears quickly on the surface of the specimen during shaking and disappears quickly upon squeezing.	Laminated	Alternating layers of varying materials or color with the layers less than 6 mm thick; note thickness.
Criteria for I	Describing Toughness	Fissured	Breaks along definite planes of fracture with little resistance to fracturing.
Description	Criteria	Slickensided	Fracture planes appear polished
Low	Only slight pressure is required to roll the thread near the plastic limit.	Sickensided	or glossy, sometimes striated.
	The thread and the lump are weak and soft.	Blocky	Cohesive soil that can be broken down into small angular lumps which resist further breakdown.
Medium	Medium pressure is required to roll the thread to near plastic limit. The thread and the lump have medium stiffness.	Lensed	Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay; note thickness.
High	Considerable pressure is required to roll the thread to near the plastic limit. The thread and the lump have very high stiffness.	Homo- geneous	Same color and appearance throughout.

Figure 6 ASTM Criteria For Describing Soil





Criteria for I	Describing the Reaction with HCI	Criteria fe	or Describing	Plasticity			
Description	Criteria	Description					
None	No visible reaction	Nonplasti		A 1/8 inch (3 mm) thread cannot be rolled at any water content. The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit.			
Weak	Some reaction, with bubbles forming slowly	Low	The thread				
Strong	Violent reaction, with bubbles forming immediately						
Criteria for	Describing Consistency	Medium	much time	d is easy to re is required to it. The thread	o reach the		
Description	Criteria		rolled after	r reaching th	e plastic limit. en drier than		
Very Soft	Thumb will penetrate soil more than 1 inch (25 mm)	High	the plastic		me relling and		
Soft	Thumb will penetrate soil about 1 inch (25 mm)	nyn	kneading to The thread times after	to reach the p d can be rero r reaching the	illed several e plastic limit.		
Firm	Thumb will indent soil about 1/4 inch (6 mm)	*		can be forme when drier th	ed without han the plastic		
Hard	Thumb will not indent soil but readily indented with thumbnail		ation of inorga	anic Fine-G	rained Soils		
Very Hard	Thumbnail will not indent soil	Soil	Dry Strength	Dilatancy	Toughness		
Criteria for I	Describing Cementation	-	170201 20071VI		000 000 000 000		
Description	Criteria	ML	None to low	Slow to rapid	Low or thread cannot be formed		
Weak	Crumbles or breaks with handling or little finger pressure	CL	Medium to high	None to slow	Medium		
Moderate	Crumbles or breaks with considerable finger pressure	МН	Low to	None to	Low to medium		
Strong	Will not crumble or break with finger pressure	СН	medium High to very	Slow	High		
Criteria for I	Describing Particle Shape		high	.,,,,,,,	i i i i		
where length	shape shall be described as follows , width, and thickness refer to	Criteria	or Describing	Moisture Co	ondition		
	rmediate, and least dimensions of a sectively (see page 104).	Description					
Flat	Particles with width/thickness ratio > 3	Dry	Absence of the touch	of moisture, o	dusty, dry to		
Elongated	Particles with length/width ratio > 3	Moist	Damp but	no visible w	ater		
Flat and	Particles meet criteria for both flat	Wet	Visible fre	e water, usua	ally soil is		

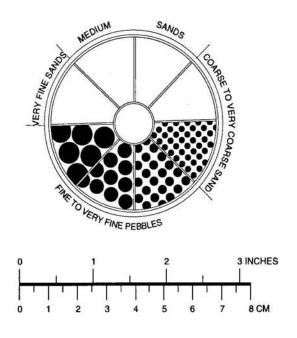
Figure 6 ASTM Criteria for Describing Soil (cont.)





SEDIMENT PARTICLE SIZE AND SHAPE ESTIMATES

GRAPH FOR DETERMINING SIZE OF SEDIMENTARY PARTICLES



COBBLES RANGE FROM 6.4 TO 25.6 cm (~2.5 TO 10.1 INCHES) BOULDERS ARE LARGER THAN 25.6 cm (>10.1 INCHES)

SEDIMENT PARTICLE SHAPES

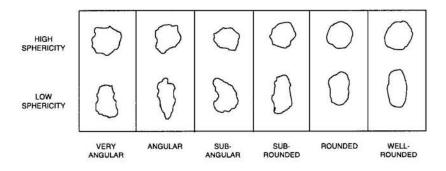


Figure 7 Sediment Particle Size and Shape Estimates





- 5. Moisture content. The amount of soil moisture (dry, moist, or wet).
- 6. Relative density or consistency. An estimate of density of a granular soil or consistency of a cohesive soil, usually based on the standard penetration test results (see Table 1).
- 7. Soil Structure or Mineralogy. Description of discontinuities, inclusions, and structures. Includes joints, fissures, and slickensides.

4. Core Logging

4.1 Handling of Core

After the core has been recovered from the corehole and the core barrel has been opened, the core should be placed in a core box. The top of the core should be placed at the back left corner of the core box, and the remaining core placed to the right of the preceding section (see Figure 8). The core box should be filled in this manner, moving to the front sections of the core box. The beginning of each run should be marked on the core and also noted with a marked wooden block.

4.2 Rock Description

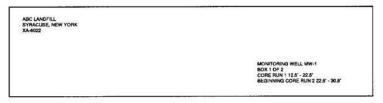
Each stratigraphic unit in the core shall be logged. A line marking the depth of the top and the bottom of the unit shall be drawn horizontally. In classifying the rock, the geologist should avoid being too technical, as the information presented must be used by numerous people with widely divergent backgrounds.

The classification and description of each unit should be given in the following order, as applicable:

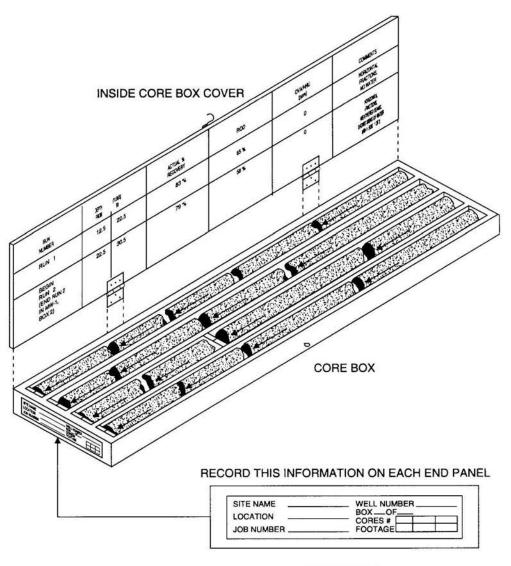
- 1. Unit designation (Miami oolite, Clayton Formation, Chattanooga shale);
- 2. Rock type;
- 3. Hardness;
- 4. Degree of weathering;
- 5. Texture;
- 6. Structure;







EXAMPLE: OUTSIDE CORE BOX COVER



SIDE PANELS

Figure 8 Core Box





- 7. Color;
- 8. Solution and void conditions;
- 9. Swelling properties;
- 10. Slaking properties; and
- 11. Additional description, such as mineralization, size, and spacing shale seams, etc.

Variations from the general description of the unit and features not included in the general description shall be indicated by brackets and lines to show the depth and the interval in the core where the feature exists. These variations and features shall be identified by terms that will adequately describe the feature or variation so as to delineate it from the unit. These may be zones or seams of different color, texture, etc., from that of the unit as a whole, such as staining; variations in texture; shale seams, gypsum seams, chert nodules, calcite masses, etc.; mineralized zones; vuggy zones, joints, fractures; open and/or stained bedding planes; faults, shear zones, gouge; cavities' thickness, open or filled, nature of filling, etc.; or any core left in the bottom of the hole after the final pull.

Rock Type and Lithology

- 1. Rock will be classified according to the following 24 types:
 - Sandstone
 - Conglomerate
 - Coal
 - Compaction Shale
 - Cemented Shale
 - Indurated Clay
 - Limestone
 - Chalk
 - Gneiss
 - Schist





- Graywacke
- Quartzite
- Dolomite
- Marble
- Soapstone and Serpentine
- Slate
- Granite
- Diorite
- Gabbro
- Rhyolite
- Andesite
- Basalt
- Tuff or Tuff Breccia
- Agglomerate or Flow Breccia
- 2. Lithologic characteristics should be included to differentiate rocks of the same classification. These adjectives should be simple and easily understood, such as shaly, sandy, dolomitic, etc. Inclusions, nodules, and concretions should also be noted here.
- 3. It is important to maintain a simple but accurate rock classification. The rock type and lithologic characteristics are essentially used to differentiate the rock units encountered.

Hardness

The terms for hardness, as outlined below, were modified to include the use of a rock hammer.

1. **Very soft** or plastic - can be deformed by hand (has a rock-like character but can be broken easily by hand).



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- 2. **Soft** can be scratched with a fingernail (cannot be crumbled between fingers but can be easily pitted with light blows of a geology hammer).
- 3. **Moderately hard** can be scratched easily with a knife; cannot be scratched with a fingernail (can be pitted with moderate blows of a geology hammer).
- 4. **Hard** difficult to scratch with a knife (cannot be pitted with a geology hammer but can be chipped with moderate blows of the hammer).
- 5. **Very hard** cannot be scratched with a knife (chips can be broken off only with heavy blows of the geology hammer).

Weathering

The degree and depth of weathering is very important and should be accurately detailed in the general description and clearly indicated on the drill log.

- 1. **Unweathered** no evidence of any mechanical or chemical alteration.
- 2. **Slightly weathered** superficial discoloration, alteration, and/or discoloration along discontinuities; less than 10% of the rock volume is altered; strength is essentially unaffected.
- 3. **Moderately weathered** discoloration is evident; surface is pitted and altered, with alterations penetrating well below rock surfaces; 10% to 50% of the rock is altered; strength is noticeably less than unweathered rock.
- 4. **Highly weathered** entire section is discolored; alteration is greater than 50%; some areas of slightly weathered rock are present; some minerals are leached away; retains only a fraction of its original strength (wet strength is usually lower than dry strength).
- 5. **Decomposed** saprolite; rock is essentially reduced to a soil with a relic rock texture; can be molded or crumbled by hand.

Texture

Texture is used to denote the size of the grains or crystals comprising the rock, as opposed to the arrangement of the grains or crystals, which is considered a structure.

1. **Aphanitic** - grain diameter less than 0.004 inch (0.1 mm); individual grains or crystals are too small to be seen with the naked eye.





- 2. **Fine-grained, finely crystalline** grain diameter between 0.004 inch (0.1 mm) and 0.003 (1 mm); grains or crystals can be seen with the naked eye.
- 3. **Medium-grained, crystalline** grain diameters between 0.003 foot (1 mm) and 0.0175 foot (5 mm).
- 4. **Coarse-grained, coarsely crystalline** grain diameter greater than 0.0175 foot (5 mm).

Structure

The structural character of the rock shall be described in terms of grain or crystal alignment, bedding, and discontinuities, as applicable. The terms may be used singularly or paired.

1. **Foliation and/or lineation** - give approximate dip uniformity, degree of distinctiveness, banding, etc.

2. **Joints:**

- a. Type bedding, cleavage, foliation, extension, etc.
- b. Degree of openness tight or open.
- c. Surface or joint plane characteristics smooth, rough, undulating.
- d. Weathering degree, staining.
- e. Frequency see (4).

3. Fractures, shears, gouge:

- a. Nature single plane or zone. (Note thickness.)
- b. Character of materials in plane or zone.
- c. Slickensides.

4. Frequency:

- a. Intact spacing greater than 6 feet (2 m).
- b. Slightly jointed (fractured) spacing 3 feet (1 m) to 6 feet (2 m).
- c. Moderately jointed (fractured) spacing 1 foot (0.3 m) to 3 feet (1 m).
- d. Highly jointed (fractured) spacing 0.3 foot (9.1 cm) to 1 foot (0.3 m).
- e. Intensely jointed (fractured) spacing less than 0.3 foot (9.1 cm).
- 5. **Bedding** is used to describe the average thickness of the individual beds within recognized unit, and the terms thick, medium, or thin should not be applied to the individual beds. "Parting" and "band" are used to describe single stratum as outlined below:
 - a. Massive over 3 feet thick (1 m).
 - b. Thick 1 foot (30.5 cm) to 3 feet (1 m) thick.
 - c. Medium 0.3 foot (9.1 cm) to 1 foot (30.5 cm) thick.
 - d. Thin 0.1 foot (3.0 cm) to 0.3 foot (9.1 cm) thick.



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- e. Band 0.02 foot (6 mm) to 0.1 foot (3.0 cm) thick, described to the nearest 0.01 foot.
- f. Parting less than 0.02 foot (6 mm).
- g. Paper-thin parting.

The terms and descriptions for the structure of the rock are to be used to describe the character of the rock units recognized and are not to be used as a substitute for describing individual discontinuities. Except for areas where the rock is intensely fractured or jointed, each discontinuity should be described on the log as to position, dip, staining, weathering, breccia, gouge, etc.

Color is often valuable in correlating or differentiating samples, but can be misleading or uninformative. The color of a sample should represent the sample in terms of basic hues (i.e., red, blue, gray, black), supplemented with modifying hues as required (i.e., bluish gray, mottled brown). The core should be surface wet when describing the color; if it is dry, the log should indicate "dry color." Subjective colors, such as buff or maroon, should not be used. Specific color charts, such as the Mumsel Color Chart or the Color Index in the Colorado School of Mines, Quarterly, Volume 50, No. 1, are useful in describing color of samples. When such a chart or index is used, it should be noted on the log in the remarks column.

Solution and Void Conditions shall be described in detail, as these features can affect the strength of the rock and can indicate potential seepage paths through the rock. When cavities are detected by drill action, the depth to top and bottom of the cavity should be determined by measuring the stick-up of the drill tools when the cavity is first encountered and again at the bottom, as it is very difficult to reconstruct cavities from the core alone. Filling material, when present and recovered, should be described in detail opposite the cavity. When no material is recovered from the area of the cavity, the inspector should note the probable conditions of the cavity as determined from observing the drilling action and the color of the drill fluid. If the drill action indicated material was present (i.e., slow rod drop, no loss of drill water, noticeable change in color of water return), it should be noted on the log that the cavity was probably filled and the materials should be described as best as possible from the cuttings or traces left on the core. If drill action indicates the cavity was open (i.e., no resistance to the drill tools, loss of drill fluid), this should be noted on the drill log. Partially filled cavities should also be noted. All of these observations require close observation of the drill action and water return by both the inspector and the driller; accurate measurement of stick-ups; and detailed inspection of the core. When possible, filling material should be wrapped in foil if left in the core box. If the material is to be tested or examined in the lab, it should be sealed in a jar with proper labels and a spacer, with a note showing the disposition of the material should be placed in the core box at the point from which the material was taken. Terms to describe voids encountered shall be as follows:

- 1. **Porous** voids less than 0.003 foot (1 mm) in diameter.
- 2. **Pitted** voids 0.03 foot (1 mm) to 0.02 foot (6 mm) in diameter.
- 3. **Vug** voids 0.02 foot (6 mm) to the diameter of the core.
- 4. **Cavity** voids greater than diameter of the core.





4.3 Core Labeling

The top of the core should be shown on each piece of core with an arrow written in a black, waterproof marker. The arrow will indicate which end of the core is nearer the ground surface. Other core markings may include locations of mechanical breaks and drilling footages.

4.4 Core Box Labeling

Each core box should be labeled as follows:

- On the top left corner of the outer core box, the project name, site location (city and state), and project number should be written.
- On the lower right corner of the outer core box, the corehole number (e.g., MW1, BH2), core box number (e.g., 1 of 2, 2 of 2), and the interval of the core run contained in the core box should be written.
- The side panels should be marked as indicated in Figure 8.
- The inside of the core box cover should be marked as indicated in Figure 8.

4.5 Core Storage

It is important to use proper-sized (HQ or NQ) wooden core boxes for rock core storage. After labeling the box and before closing the box for final storage or shipment, wooden spacers should be inserted into each compartment that contains rock core. This will prevent lateral movement of the cores, which could damage the rock material during handling.

After properly logging, labelling, and packing the cores, the core boxes should be stored in a dry location, preferably off of the floor on a pallet. The boxes can be stacked to a reasonable height so as not to be unstable, with end labelling facing out.

5. References

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STANDARD OPERATING PROCEDURE GROUNDWATER WELL SAMPLING

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1 Scope and Application

This Standard Operating Procedure (SOP) describes the procedures for the sampling of groundwater wells and is primarily concerned with the collection of water samples from the saturated zone of the subsurface. Every effort must be made to ensure that the sample is representative of the particular zone of water being sampled. There is numerous state and federal standards and guidelines on groundwater sample that should be relative to project requirements and site conditions. This SOP can be followed for all routine sample collection activities which may include: field measurements (monitoring) or sample collection for chemical, radiological or physical analysis. Site-specific sampling procedures vary depending on the data quality objectives (DQOs) identified in program/project planning documents.

Analysis of groundwater samples may determine pollutant concentrations and its risk to public health, welfare, or the environment; extent of contaminants; and confirmation of remedial standards. Sampling methods should be determined based on regulatory standards needed to report acceptable analytical results. The project planning documents should clearly indicate the type of sampling to be completed.

Procedures for sample handling are defined in E & E Environmental Sample Handling, Packaging and Shipping SOP ENV 3.16. Site-specific sample handling procedures are dependent on the project DQOs.

Procedures for equipment decontamination are defined in E & E Sampling Equipment Decontamination SOP ENV 3.15. Site-specific equipment decontamination procedures are dependent on the project DQOs.

This groundwater sampling SOP is intended for use by personnel who have knowledge, training and experience in the field sampling activities being conducted.

2 Definitions and Acronyms

E & E Ecology and Environment, Inc.

FID Flame ionization detector
PID Photo ionization detector

SOP Standard Operating Procedure

SSSP Site-Specific Safety Plan

μm Micrometer

VOA Volatile organic analysis
VOC Volatile organic compound

3 Procedure Summary

This procedure covers routine groundwater sampling. Federal and state regulatory agencies also have standards and guidance for groundwater sampling that supersede this SOP if required for the project. Before sampling a well, the well must be purged. This may be done with a number of portable devices, including bailers, submersible pumps, bladder pumps, gasdriven pumps, gas-lift pumps, suction-lift pumps, and inertial-lift pumps. Refer to E & E's

guidance on Groundwater Sampling Devices for information on different groundwater purging and sampling devices. Domestic drinking water or irrigation wells may have a downhole well pump already installed that could be used for purging and sample collection.

For routine sampling, a minimum of three well volumes should be removed during well purging to ensure that groundwater samples collected are representative of aquifer conditions. For low flow sampling, water quality parameters are measured and well purging is complete when the parameters and water depth has stabilized. After purging is complete and the properly prepared sample containers have been selected, sample collection may proceed. Numerous types of sampling devices are available for the collection of the groundwater sample, but care should be taken when selecting the sampling device, as some will affect the integrity of the sample.

Sampling should occur in a progression beginning with the well(s) suspected to be least contaminated and finishing with those suspected to be most contaminated. Ideally, a dedicated sampling device should be used for each well. However, dedicated sampling devices may not be practical if there are a large number of groundwater samples to be collected. In this case, sampling devices should be cleaned prior to and between sampling locations and events using the decontamination procedures outlined in E & E's SOP for *Equipment Decontamination* (ENV 3.15).

Domestic well sampling may be conducted to establish base level concentrations of chemicals, metals, bacteria or other potential contaminants prior to work in an area; or to assess the impact of nearby activities; or for other reasons. Unique considerations apply to domestic wells due to construction, frequency of use, access, or other factors.

4 Cautions

4.1 Purging

In a nonpumping well, there will be little or no vertical mixing of the water, and stratification will occur. The well water in the screened interval will mix with the groundwater due to normal flow patterns, but the water above the screened interval will remain isolated and become stagnant. Sampling team members should realize that stagnant water will not be representative of aquifer conditions and may contain foreign material inadvertently or deliberately introduced from the ground surface or from well construction. To safeguard against collecting non-representative stagnant water during sampling, the following guidelines and techniques should be adhered to:

- As a general rule, all wells should be pumped or bailed prior to sample collection. Evacuation of a minimum of one volume of water in the well casing, and preferably three to five volumes, is recommended for a representative sample. In a high-yielding groundwater formation and where there is no stagnant water in the well above the screened section, evacuation prior to sample collection is not as critical. However, in all cases where the monitoring data are to be used for enforcement actions, evacuation is recommended.
- For wells that can be pumped or bailed dry, the well should be evacuated and allowed to recover prior to sample collection. If the recovery rate is fairly rapid and time allows, evacuation of more than one volume of water is preferred.
- A non-representative sample can also result from excessive pumping of the well.
 Stratification of the leachate concentrations in the groundwater formation may occur or compounds that are heavier than water may sink to the lower portions of the aquifer.

Excessive pumping can dilute or increase the contaminant concentrations from what is representative of the sampling point of interest.

Stagnant water may be a relatively minor issue in domestic drinking water wells that are used on a regular basis; however, such wells should also be purged prior to sample collection. Opening the casing in a domestic well may not be possible or may be impractical and construction information may be unavailable, making well volume calculations difficult or impossible. Treatment systems, filters, pressure tanks, storage tanks, or other apparatus' may be present in a domestic well system. When sampling to assess groundwater supply conditions it is important to collect samples upstream of all such features.

4.2 Materials

The material used to construct groundwater purging and sampling devices can have a significant impact on the analytical results. If practical, equipment that contacts the groundwater should be constructed from stainless steel, Teflon, or glass. The use of plastic should be avoided when analyzing for organics.

5 Equipment and Supplies

The equipment and supplies required for field work depend on the program/project DQOs. The following is a general list of equipment and supplies. A detailed list of equipment and supplies should be prepared based on the project planning documents. In general, the use of dedicated or disposal equipment is preferred but equipment may be re-used after thorough decontamination between sample locations (refer to E & E Sampling Equipment Decontamination SOP ENV 3.15).

- Water level indicator (e.g., electric sounder, steel tape, transducer, reflection sounder, air line, etc.);
- Depth sounder;
- Appropriate keys for well cap locks;
- Steel brush;
- · Flame ionization detector (FID) or photo ionization detector (PID);
- Oil/water interface indicator (if necessary);
- · Timepiece (preferably a stopwatch);
- · Calculator;
- Field data sheets:
- Sharp knife (locking blade);
- 5-gallon pails;
- · Plastic sheeting; and
- Tool box supplement (pipe wrenches, wire strippers, electrical tape, heat shrink, hose connectors, teflon tape, etc.).

5.1 Groundwater Sampling Devices

See E & E guidance on groundwater sampling devices.

Bailers

- · Clean, decontaminated bailers of appropriate size and construction material;
- · Nylon line (enough to dedicate to each well);
- · Winch, pulley, or electric reel (if desired);
- · Sharp knife; and
- · Aluminum foil (to wrap clean bailers).

Submersible Pumps

- Pump(s);
- Adequate power supply, generator, or battery and appropriate power cable(s);
- · Charger(s) for any battery-operated equipment;
- Electric flow controller;
- · Tubing of appropriate size, length, and construction (enough to dedicate to each well);
- · Appropriately-sized hose barbs, connectors, nipples, and clamps;
- · Safety cable (i.e., heavy-grade nylon line);
- Winch or pulley (if desired);
- · Gasoline for generator; and
- Flow meter with gate valve.

Bladder Pumps

- Non-gas contact bladder pump;
- Spare bladder(s);
- Compressor or compressed nitrogen gas;
- Battery(ies) and charger;
- Tubing of appropriate size, length, and construction (enough to dedicate to each well);
 and
- Swagelock fitting(s).

Suction Pump

- Pump;
- Tubing of appropriate size, length, and construction (enough to dedicate to each well);
- Soft, flexible tubing of appropriate size and length for use in peristaltic pump;
- Adequate power supply, generator, or battery and appropriate power cable(s);
- · Charger(s) for any battery-operated equipment;
- Gasoline (if required);
- · Appropriately-sized hose barbs, connectors, nipples, and various pipe connectors; and

· Flow meter with gate valve.

For low flow sampling, meters for measuring water quality parameters are required. Typically in-line YSI meters are used to measure temperature, pH, electrical conductance, and conductivity and a separate meter is used to measure turbidity. Supporting equipment and supplies also may be required to address the following:

- Field logbooks and supplies (Refer to project planning documents and the E & E Field Activity Logbooks SOP DOC 2.1 for details)
- Decontamination equipment and supplies (Refer to project planning documents and E & E Sampling Equipment Decontamination SOP ENV 3.15for details)
- Sample containers, preservatives, and shipping equipment and supplies (Refer to project planning documents and the E & E Environmental Sample Handling, Packaging and Shipping SOP ENV 3.16 for details)
- Waste handling supplies (Refer to project planning documents and E & E Handling Investigation-Derived Wastes SOP ENV 3.26 for details).

6 Procedure

An overview of groundwater sampling procedures is provided in Figure 1. The methods for the low-flow procedure are included in the appropriate federal or state standards. If no standards are available follow the United States Environmental Protection Agency (EPA) Region II Guidance document titled *Groundwater Sampling Procedure, Low Stress (Low Flow) Purging and Sampling* (EPA 1998). The primary goal of low-flow purging/sampling is to provide groundwater quality data that are representative of actual aquifer conditions with minimal waste generation caused by variable sampling techniques.

All groundwater sampling is recorded on standard groundwater sampling forms. E & E's has a standard developed for low-flow sampling, but standard forms are also available in many state and federal standard guidance. The appropriate sampling form should be selected and included with the project planning documents.

6.1 Sampling Preparation

- · Start at the least-contaminated well, if known;
- Remove locking well cap. Note the location of the well, time of day, and date in the field logbook or sample log;
- · Remove the well cap covering the well riser;
- · If possible, listen for indications of pressure or vacuum when opening the well riser cap;
- Test the well for volatile organic compounds (VOCs) and methane by conducting a headspace analysis with a combustible gas indicator, an FID (for VOCs and methane), or a PID (for VOCs). Record all readings in the field logbook;
- Allow sufficient time for the water level to equilibrate in the well, to ensure that measurement of groundwater elevation is accurately representative;
- Lower water level measuring device into well until the surface of the water table is encountered;

- Measure the distance from the top of the water table to a reference point on the well riser or casing (e.g., top of inside casing) and record the distance in the field logbook;
- Lower the water level measuring device to the bottom of the well, and measure the total depth of the well using the same reference point on the well riser or casing. Record the distance in the field logbook;
- Measure the diameter of the well, and calculate the volume of water in the well by multiplying the number of feet of water by the number of gallons per foot (see Section 6.7);
- Determine the required volume of groundwater to be removed from the well (e.g., three well volumes or as indicated in the planning documents);
- Place plastic sheeting on the ground around the well to minimize the likelihood of contamination of sampling equipment from soil adjacent to the well; and
- · Prepare the purging and sampling equipment.

Special considerations for domestic well sampling:

- Visually assess the well system, from the well to the tap. Identify the most appropriate
 tap or spigot from which to sample. Attempt to sample from as close to the well head as
 possible. Avoid leaky faucets, sanitary or janitorial tubs, faucets near or below ground
 level, or other features that may compromise the water sample; and
- · Remove any filters, aerators, screens, washers, or hoses from the faucet.

6.2 Purging

The amount of purging that a well receives prior to sample collection depends on the intent of the monitoring program, as well as the hydrogeologic conditions and how much pumping a well undergoes on a routine basis. Programs in which overall quality determinations of water resources are involved may require long pumping periods to obtain a sample that is representative of the groundwater. The pumped volume can be determined prior to sampling, or the well can be pumped until selected parameters (e.g., temperature, electrical conductance, pH, turbidity, etc.) have stabilized. Care must be taken to not exceed the recommended purging rate for well screens (see Table 1).

Monitoring for defining a contaminant plume requires a representative sample of a small volume of the aquifer. These circumstances require that the well be pumped enough to remove the stagnant water, but not enough to induce flow from other areas.

During purging, water level measurements may be taken regularly at 30-second intervals. The data may be used to compute water table or aquifer transmissivity and other hydraulic characteristics.

Information on the most commonly used groundwater purging and sampling devices can be found in E & E's guidance for Groundwater Sampling Devices.

6.2.1 Bailers

The equipment needed will include a clean decontaminated bailer, nylon line, a sharp knife, and plastic sheeting. Place the plastic sheeting around the well to prevent contact of the bailer or line with the ground. Attach the line to the bailer, and then lower the bailer until it is completely submerged. Pull the bailer out of the well; ensure that the line either falls onto the plastic

sheeting or never touches the ground. Empty the bailer into a 5-gallon pail. Repeat the procedure until the required purge volume has been removed. When the 5-gallon pail is full, pour the water into a 55-gallon drum or handle as indicated in the planning documents.

Table 1 Maximum Recommended Purging Rate for Monitoring Well Screens

Table I Waxi	mum Recoi		Open	Open		ended Pump	oing Rate
	Diameter	Slot	Area	Area	gpm/ft at	gpm/ft at	gpm/ft at
Screen Type	(in)	(in)	(ft²/ft)	(%)	0.1 ft/s	0.07 ft/s	0.03 ft/s
PVC	2	0.01	0.018	3.4	0.804	0.563	0.241
(machine slot)	2	0.02	0.033	6.4	1.496	1.047	0.449
	2	0.025	0.042	8.0	1.870	1.309	0.561
	2	0.04	0.060	11.5	2.693	1.885	0.808
	2	0.051	0.075	14.4	3.385	2.369	1.015
	4	0.01	0.036	3.4	1.608	1.126	0.482
	4	0.02	0.067	6.4	2.992	2.094	0.898
	4	0.025	0.083	8.0	3.740	2.618	1.122
	4	0.04	0.120	11.5	5.386	3.770	1.616
	4	0.051	0.151	14.4	6.773	4.741	2.032
PVC	2	0.01	0.047	9.0	2.119	1.484	0.636
(wound)	2	0.02	0.089	17.0	3.989	2.793	1.197
	2	0.03	0.124	23.7	5.579	3.905	1.674
	2	0.04	0.156	29.7	6.981	4.887	2.094
	2	0.05	0.183	34.9	8.197	5.738	2.459
	4	0.01	0.078	7.5	3.522	2.465	1.057
	4	0.02	0.147	14.1	6.607	4.625	1.982
	4	0.03	0.208	19.9	9.350	6.545	2.805
	4	0.04	0.262	25.0	11.750	8.225	3.525
	4	0.05	0.309	29.5	13.869	9.708	4.161
Stainless Steel	2	0.01	0.090	17.1	4.021	2.814	1.206
(wire-wound)	2	0.02	0.157	30.0	7.044	4.931	2.113
	2	0.03	0.210	40.2	9.444	6.610	2.833
	2	0.04	0.253	48.4	11.376	7.963	3.413
	2	0.05	0.287	54.8	12.872	9.010	3.862
	4	0.01	0.177	16.9	7.948	5.563	2.384
	4	0.02	0.307	29.3	13.776	9.643	4.133
	4	0.03	0.410	39.1	18.388	12.872	5.517
	4	0.04	0.492	47.0	22.097	15.468	6.629
	4	0.05	0.560	53.4	25.120	17.584	7.536

Key:

ft = feet in = inch

 ft^2 = square feet PVC = Polyvinyl Chloride

gpm = gallons per minute s = second

6.2.2 Submersible Pumps

- · Assemble the pump, hose, and safety cable;
- Lower the pump and assembly into the well to a point a few feet below the water level;
- Attach to a power source and commence purging operations;

- Using a flow meter or pail and a stopwatch, determine the flow rate and calculate the time required to remove the required volume of water from the well;
- Place the purge water in 55-gallon drums or handle as indicated in the planning documents; and
- Lower the pump by stages until it is just above the screen, and continue to purge until
 the required volume of water has been removed from the well. In cases where the well
 will not yield water at a sufficient recharge rate, pump the well dry and allow it to recover.

6.2.3 Non-Gas Contact Bladder Pumps

- · Assemble tubing, pump, and compressor/control box;
- · For control boxes using external power, connect power source;
- Procedures for purging with a bladder pump are the same as for a submersible pump (Section 6.2.2); and
- Be sure to adjust the flow rate to allow smooth intake and discharge cycles.

6.2.4 Suction Pumps

- · Assemble the pump, tubing, and power source; and
- Procedures for purging with a suction pump are the same as for a submersible pump (Section 6.2.2).

6.2.5 Domestic Wells

- Open the faucet or spigot and allow the water to run at a steady rate for at least 15 minutes, if possible. Adjust the flow rate to minimize spikes or dips in flow pressure.
 Purging and sample collection should be from the cold water supply if given a choice between hot and cold water.
- Monitor the pH, specific conductance, temperature, and turbidity of the water removed to confirm that the well has been adequately purged.

6.2.6 Low Flow Purging

- Turn on pump and collect the initial water discharged.
- Record the initial temperature, pH, conductivity, electrical conductance, DO, and turbidity in the groundwater sampling form.
- Purge the well using an initial flow rate of 100 to 500 mL/min; however, the flow rate should be adjusted to minimize drawdown to no more than 0.3 foot during purging and sampling. The water level should be monitored with a waterlevel indicator at 5-minute intervals.
- If 0.3-foot drawdown is exceeded and cannot be re-established, establishment of zero drawdown (i.e., water elevation stabilization at a constant or increasing level during purging) will be attempted. The decrease in water level greater than 0.3 foot is allowable as long as the water elevation stabilizes and remains stable or increases during the remainder of purging and sampling.

- Record electrical conductance, pH, specific conductivity, temperature, turbidity, and DO every 5 minutes or one quarter of a well volume until stabilization of all parameters is achieved. The purging will be considered complete after the field parameters have stabilized for three successive readings.
- The readings are considered stable when three successive readings are within the following USEPA guidelines or guidelines specific to the project:
 - \circ +/-10 mV for ORP.
 - o +/-0.1 for pH.
 - o +/- 3% for specific conductivity and temperature.
 - +/- 10% for turbidity and DO.
- Once stabilized and turbidity is 50 NTUs or less, the groundwater sample will be collected.
- If turbidity is unstable (i.e., > will still be collected and the final turbidity will be recorded,
- If sample turbidity is greater than 50 NTUs, a second sample will be collected by attaching a disposable 0.45-micron in-line filter to the end of the tubing and the filtered sample along with an unfiltered sample will be submitted to the laboratory for both dissolved and total (respectively) metals analyses.

6.3 Sampling

Groundwater samples can be obtained through the use of a number of groundwater sampling devices. Each groundwater sampling device has its advantages (and disadvantages) over other devices. Ideally, groundwater sampling devices should be completely inert, economical to manufacturer, easily cleaned for reuse, able to operate at remote sites in the absence of power sources, and capable of delivering variable rates for both well purging and sample collection. There are several other factors to consider when choosing a groundwater sampling device and care should be taken when selecting the device. Refer to E & E's guidance for Groundwater Sampling Devices for additional information.

6.3.1 Bailers

- Make sure that clean plastic sheeting has been placed around the well;
- Attach a line to the bailer. If a bailer was used for purging, the same bailer and line may be used for sampling;
- Lower the bailer slowly and gently into the well, taking care not to shake the well casing
 or splash the bailer into the water. Lower the bailer to different points adjacent to the
 well screen to ensure that a representative water sample is collected;
- · Slowly and gently retrieve the bailer from the well, minimizing contact with the well riser;
- Remove the cap from a sample container and place the cap on plastic sheeting or in a location where it will not be contaminated. Refer to Section 6.6 for special considerations for volatile organic analysis (VOA) samples;
- · Slowly pour the water into the container;
- Filter and preserve samples as required by the planning documents.

 \square 10%), but less

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- · Replace sample container cap;
- · Mark the water level on the container with a pen;
- Prepare the necessary quality assurance samples as outlined in the planning documents;
- Record sample information in the field logbook or on field data sheets, and complete the chain-of-custody form;
- · Package samples in accordance with the planning documents; and
- Repeat this process until all groundwater samples have been collected.

6.3.2 Submersible Pumps

- Allow the well to recharge after purging, keeping the pump just above the screened interval:
- Attach a gate valve to the discharge hose, and reduce the flow rate to one appropriate for sample collection;
- The VOC aliquot of the sample will be collected first followed any remaining aliquots. Pumping will be performed at a very slow rate to minimize volatilization and turbidity.
- Prepare the sample containers;
- If no gate valve is available, discharge the sample into a clean jar and fill the sample containers from the jar;
- · Complete the sampling and documentation procedures as outlined in Section 6.3.1; and
- Upon completion, remove the pump and assembly and properly decontaminate the pump prior to use in the next well. Do not reuse the discharge tubing in a separate well.
 If dedicated to a particular well, tubing may be left in place for future sampling events.

6.3.3 Bladder Pump

- Allow the well to recharge after purging;
- · Prepare the sample containers;
- Turn the pump on. Increase the cycle time and reduce the pressure to the minimum that will allow groundwater to come to the surface;
- · Complete the sampling and documentation procedures as outlined in Section 6.3.1:
- Upon completion, remove the tubing from the well and either replace the teflon tubing and bladder with new dedicated tubing and bladder, or properly decontaminate the existing material;
- Nonfiltered groundwater samples should be collected directly from the outlet tubing into the sample containers; and
- Filtered groundwater samples should be obtained by connecting the pump outlet tubing directly to the filter unit. The pump pressure should be reduced to prevent a pressure buildup on the filter, which could damage the pump bladder.

6.3.4 Suction Pumps

- · Allow the well to recharge;
- Attach a gate valve to the discharge line if the suction pump discharge rate cannot be controlled, or discharge the sample into a clean glass jar and fill the sample containers from the jar;
- Sample as outlined in Section 6.3.1; and
- Upon completion, remove the tubing and properly decontaminate the pump prior to use in the next well. Do not reuse the tubing in a separate well. If dedicated to a particular well, tubing may be left in place for future sampling events.

6.3.5 Domestic Well Sampling

- Reduce flow rate to a smooth flowing water stream without splashing prior to sample collection. This step is especially important during sample collection for VOC analysis; and
- · Sample as outlined in Section 6.3.1.

6.4 Filtering

Samples being analyzed for total dissolved metals and total organic carbons may require filtering. Two types of filters are commonly used: barrel filters and vacuum filters. A barrel filter works with a bicycle pump, which is used to build up positive pressure in the chamber containing the sample. Water is then forced through 0.45-µm filter paper into a jar. The barrel itself is filled manually.

A vacuum filter involves two chambers: the upper chamber contains the sample, and a 0.45-µm filter divides the two chambers. Using a portable vacuum pump, air is withdrawn from the lower chamber, creating a vacuum, which causes the sample to move through the filter into the lower chamber. Repeated pumping may be required to drain all of the sample into the lower chamber. If preservation of the samples is necessary, this should be done after filtering.

6.5 Post Operation

After all samples have been collected and preserved, the sampling equipment should be properly decontaminated to prevent cross-contamination of samples.

- Decontaminate all equipment according to the planning documents;
- Replace sampling equipment in storage containers;
- Prepare groundwater samples for shipment. Check sample documentation and make sure samples are properly packed for shipment; and
- Organize field notes into a report format and transfer logging information to appropriate forms.

6.6 Special Consideration for VOA Sampling

The proper collection of a sample for dissolved VOCs requires minimal disturbance of the sample to limit volatilization and subsequent loss of volatiles from the sample.

Sample retrieval systems suitable for the valid collection of volatile organic samples include: positive-displacement bladder pumps, gear-driven submersible pumps, and syringe samplers and bailers. Field conditions and other constraints will limit the choice of appropriate systems. The principal objective is to provide a valid sample for analysis that has been subjected to the least amount of turbulence possible.

The following procedures should be followed when collecting VOA samples:

- Open the vial, set the cap in a clean place, and place the proper amount of preservatives (HCI) in the vial;
- Fill the vial to the top until a convex meniscus forms on the top of the vial. Do not overfill the vial;
- Check that the cap has not been contaminated, and carefully cap the vial. Place the cap directly over the top and screw down firmly. Do not overtighten and break the cap;
- Invert the vial and tap gently. If an air bubble appears, discard the sample and begin again. It is imperative that no entrapped air remains in the sample vial;
- · Place the VOA vial in a cooler, oriented so that it is lying on its side, not straight up; and
- The holding time, under most protocol parameters, for VOAs is 14 days. It is recommended that samples be shipped or delivered to the laboratory daily. Ensure that the samples remain at 4 degrees Celsius, but do not allow them to freeze.

6.7 Calculations

Table 2 presents the volume of water in different size casings and holes. To determine the volume of water in a well, the calculations are as follows:

$$V = Tr^2(0.163)$$

Where:

- V = Static volume of well in gallons
- T = Depth of water in well, measured in feet (determined by subtracting the static water level from the total depth of the well)
- r = Inside radius of well casing, measured in inches
- 0.163 = A constant conversion factor for the conversion of the casing radius from inches to feet and cubic feet to gallons

Table 2 Volume of Water in Casing or Hole

Diameter of	or water in outlin			
Casing or Hole	Gallons per Foot	Cubic Feet per	Liter per Meter of	Cubic Meters per
(in)	of Depth	Foot of Depth	Depth	Meter of Depth
1	0.041	0.0055	0.509	0.509 x 10 ⁻³
1.5	0.092	0.0123	1.142	1.142 x 10 ⁻³
2	0.163	0.0218	2.024	2.024 x 10 ⁻³
2.5	0.255	0.0341	3.167	3.167 x 10 ⁻³
3	0.367	0.0491	4.558	4.558 x 10 ⁻³
3.5	0.500	0.0668	6.209	6.209 x 10 ⁻³
4	0.653	0.0873	8.110	8.110 x 10 ⁻³
4.5	0.826	0.1104	10.260	10.260 x 10 ⁻³
5	1.020	0.1364	12.670	12.670 x 10 ⁻³
5.5	1.234	0.1650	15.330	15.330 x 10 ⁻³
6	1.469	0.1963	18.240	18.240 x 10 ⁻³
7	2.000	0.2673	24.840	24.840 x 10 ⁻³
8	2.611	0.3491	32.430	32.430 x 10 ⁻³
9	3.305	0.4418	41.040	41.040 x 10 ⁻³
10	4.080	0.5454	50.670	50.670 x 10 ⁻³
11	4.937	0.6600	61.310	61.310 x 10 ⁻³
12	5.875	0.7854	72.960	72.960 x 10 ⁻³
14	8.000	1.0690	99.350	99.350 x 10 ⁻³
16	10.440	1.3960	129.650	129.650 x 10 ⁻³
18	13.220	1.7670	164.180	164.180 x 10 ⁻³
20	16.320	2.1820	202.680	202.680 x 10 ⁻³
22	19.750	2.6400	245.280	245.280 x 10 ⁻³
24	23.500	3.1420	291.850	291.850 x 10 ⁻³
26	27.580	3.6870	342.520	342.520 x 10 ⁻³
28	32.000	4.2760	397.410	397.410 x 10 ⁻³
30	36.720	4.9090	456.020	456.020 x 10 ⁻³
32	41.780	5.5850	518.870	518.870 x 10 ⁻³
34	47.160	6.3050	5.3050 585.680 585.680	
36	52.880	7.0690	656.720	656.720 x 10 ⁻³

¹ Gallon = 3.785 liters

7 Quality Assurance/Quality Control

Prior to initiating field work, the project planning documents should be reviewed by field personnel to identify sampling procedure(s) that will most likely provide sediment samples that meet project DQOs.

The program/project manager should identify personnel for the field team who have knowledge, training and experience in the groundwater sampling activities being conducted. One member of the field team should be designated as the lead for groundwater sampling and will be responsible, with support from other field personnel, for implementing the procedures in this SOP. The program/project manager should also identify additional personnel, if necessary, to

¹ Meter = 3.281 feet

¹ Gallon water weighs 8.33 pounds = 3.785 kilograms

¹ Liter water weighs 1 kilogram = 2.205 pounds

¹ Gallon per foot of depth = 12.419 liters per foot of depth

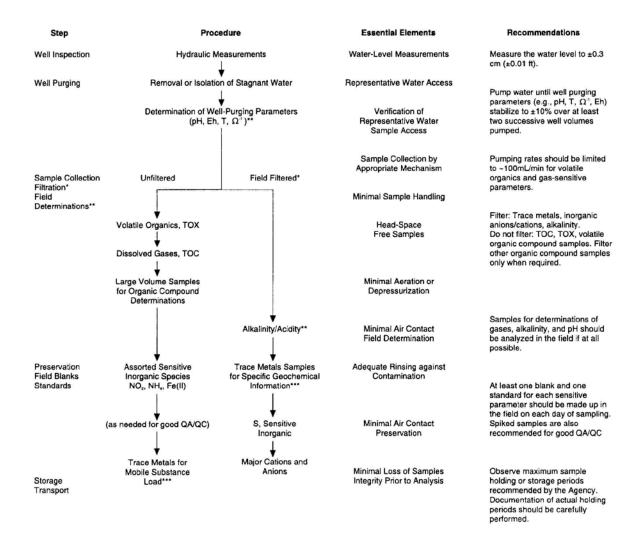
¹ Gallon per meter of depth = 12.319×10^3 cubic meters per meter of depth

complete ancillary procedures (e.g., field logbook documentation, equipment decontamination, sample shipment, and waste disposal).

The groundwater sampling lead should prepare a detailed equipment checklist before entering the field and verify that sufficient and appropriate equipment and supplies are taken into the field.

Collecting representative groundwater samples is an important quality consideration. The areas should be addressed during implementation of the sampling procedures:

- Log documentation should be reviewed to determine whether the required volume of purge water was removed from the well and that the temperature, electrical conductance, and pH had been stabilized to ensure that a representative water sample of the aguifer was obtained;
- The purging and sampling devices should be made of materials and utilized in a manner that will not interact with or alter the analysis;
- The results generated by these procedures are reproducible as demonstrated through the use of duplicate samples; and
- The possibility of cross-contamination is reduced by collecting samples from the least contaminated well first. Rinsate blanks should be incorporated where dedicated sampling and purging equipment is not utilized and decontamination of the equipment between sampling events is required.



Denotes samples that should be filtered to determine dissolved constituents. Filtration should be accomplished preferably with in-line filters and pump pressure or by N, pressure methods. Samples for dissolved gases or volatitle organics should not be filtered. In instances where well development procedures do not allow for turbidity-free samples and may bias analytical results, split samples should be spiked with standards before filtration. Both spiked samples and regular samples should be analyzed to determine recoveries from both types of handling.

Figure 1 Generalized Flow Diagram of Groundwater Sampling Protocol

^{**} Denotes analytical determinations that should be made in the field.

8 Health and Safety

Prior to entering the field, all field personnel should formally acknowledge that they have read and understand the project specific health and safety plan.

Standard safe operating practices should be followed, such as minimizing contact with potential contaminants in both the vapor phase and liquid matrix through the use of respirators and protective clothing.

9 Special Project Requirements

Project or program-specific requirements that modify this procedure should be entered in this section and included with the project planning documents.

10 References

- American Society for Testing and Material (ASTM), 2007, *Standard Guide for Sampling Groundwater Monitoring Wells*, D4448 01, ASTM International, West Conshohocken, PA, www.astm.org.
- _____, 2005, Standard Guide for Purging Methods for Wells Used for Groundwater Quality Investigations, D6452 99, ASTM International, West Conshohocken, PA, www.astm.org.
- Florida Department of Environmental Protection (FDEP). 2008. Standard Operating Procedures for Field Activities. DEP-SOP-001/01. December 2008. Online at http://www.dep.state.fl.us/labs/qa/sops.htm. FS 2200 Groundwater Sampling
- US Army Corps of Engineers Kansas City District, 2002, Revised SOP for Low-flow Groundwater Purging and Sampling. Version 1.3.
- USEPA, 1998, Groundwater Sampling Procedure, Low Stress (Low Flow) Purging and Sampling, Region II Guidance document.

END OF SOP

ecology and environment, inc.

STANDARD OPERATING PROCEDURE

SAMPLING EQUIPMENT DECONTAMINATION

SOP NUMBER: ENV 3.15

REVISION DATE: 5/25/2012 SCHEDULED REVIEW DATE: 5/25/2017

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10	References	С

1 Scope and Application

This Standard Operating Procedure (SOP) describes the routine procedures utilized by E & E personnel in the field for decontaminating sampling equipment that is not dedicated or disposal and that may have come into contact with site contaminants. It is applicable for equipment that will be re-used in the field and for equipment that will be returned to a warehouse or other storage facility prior to re-use.

Program/project specific data quality objectives (DQOs) dictate the types of sampling equipment requiring decontamination and site-specific sampling procedures should be identified in program/project planning documents. This SOP applies to equipment routinely used for:

- Water quality sampling (e.g., buckets, bailers, Kemmerers, and Niskins);
- Flow/water depth measuring (e.g., velocity meters, stream gauges, and depth sounders);
- Soil and sediment sampling (e.g., corers, augers, Van Veens, direct-push samplers, homogenization buckets, and mixing tools); and
- Miscellaneous tools (e.g., shovels, scoops, tapes/rulers/meter sticks, and cutting tools).

Decontamination is time consuming and expensive, often including analyses of field rinsates and other "blanks" to verify decontamination procedures provide equipment that meet program/project DQOs. The use of clean, dedicated, disposable equipment (e.g., Teflon or plastic bailers for groundwater sampling, aluminum bowls for soil homogenization) is preferred, whenever practicable.

This sampling equipment decontamination SOP is intended for use by personnel who have knowledge, training, and experience in the field sampling activities being conducted and who understand the importance of decontamination in meeting program/project-specific DQOs.

The SOP does not address personnel decontamination. As part of the health and safety plan, a personnel decontamination plan should be developed and set up before any personnel or equipment enters the areas of potential contamination.

2 Definitions and Acronyms

ASTM American Society for Testing and Materials

De-ionized water Purified water produced by distillation or by filtration through de-ionizing

columns or other means (e.g., reverse osmosis) or some combination of treatments. Program/project DQOs establish the level of purity required

(e.g., maximum level of electrical conductivity)

DQO Data quality objective

SHASP Site-specific Health and Safety Plan

SOP Standard Operating Procedure

USEPA United States Environmental Protection Agency

3 Procedure Summary

Sampling equipment decontamination procedures vary depending on the DQOs identified in the program/project planning documents . These documents address the types and degrees of contamination anticipated and identify appropriate decontamination procedures, materials, and wastes handling.

A decontamination line is set up in the contamination reduction zone, outside of the contamination "hot" zone, where personnel follow a multi-step decontamination procedure. If a formal decontamination line is established for the site, then all equipment decontamination must be completed with the "hot" zone.

This procedure can be expanded to include additional or alternate wash/rinse steps designed to remove specific target analytes/compounds, if required by site-specific work plans or as directed by a particular client.

4 Cautions

Decontamination of sampling equipment left in situ for long periods (e.g., groundwater pumps, stack samplers, continuous flow samplers) is addressed in program/project-specific planning documents.

Sites with biohazards are not considered routine operations. Biohazard site sampling equipment decontamination is addressed site-specific program/project planning documents.

Sites with explosive hazards are not considered routine operations. Explosives site sampling equipment decontamination is addressed in site-specific program/project planning documents.

Sites requiring ultra-clean sampling methods (e.g., United States Environmental Protection Agency [USEPA] Method 1669) require ultra-clean sampling equipment decontamination. Ultra-clean sampling equipment decontamination is addressed in site-specific program/project planning documents.

Decontamination of contaminated or potentially contaminated sampling equipment may generate incompatible hazardous wastes. Only compatible waste streams, as defined in the program/project planning documents are combined for disposal.

The use of distilled/deionized water commonly available from commercial vendors may be acceptable for decontamination of sampling equipment provided that it has been verified by laboratory analysis to be analyte-free distilled/deionized water. Analyte-free deionized water is can be obtained from the project analytical laboratories if available. Distilled water available from local grocery stores and pharmacies is generally not acceptable for final decontamination rinses. Contaminant-free deionized water is that has been stored on site should not be used without testing. Any new source of water should be tested prior to use if not certified by a vendor or laboratory.

In general, use of solvents is avoided for low level environmental analysis, but may be necessary for more contaminated areas.

5 Equipment and Supplies

Planning documents provide direction on the specific equipment and supplies, and the numbers/volumes required to meet program/project-specific DQOs. The following equipment and supplies are used for routine sampling equipment decontamination:

- Appropriate protective clothing (including safety glasses or splash shield and nitrile gloves);
- Galvanized or similar wash basins;
- Waste collection drums (if required);
- Plastic buckets (5-gallon);
- Long-handled brushes;
- Spray/squeeze bottles;
- Non-phosphate detergent (e.g., Liquinox[™] or Alconox[™]);
- Pesticide grade (or equivalent) organic solvents (e.g., methanol, hexane, or other as specified in the planning documents.) if necessary based on the contaminants
- Ten percent, by volume in de-ionized water, nitric acid (ultrapure);
- Tap water;
- Deionized water (usually American Society for Testing and Materials [ASTM] Type II);
- Organic-free water;
- Plastic sheeting for ground cover;
- Paper towels;
- Trash bags;
- Aluminum foil; and
- Waste handling supplies. (Refer to project planning documents and E & E Investigation-Derived Waste SOP for details.)

Note all waters, acids and detergents should be are stored in their original containers or clearly marked clean sealable glass, plastic, or Teflon® bottles in which information from the original label has been transferred. The secondary labeling should include reagent name, source, date opened/transferred, and expiration date as well as any hazardous labels.

6 Procedures

Before entering the field personnel reviews relevant program/project planning documents (e.g., work plan, sampling and analysis plan, quality assurance project plan, health and safety plan);and select the sampling equipment decontamination procedures (e.g., organic solvent[s] to be used) that meet project DQOs.

In the field personnel should follow best practices to minimize contamination of equipment and prevent cross contamination of cleaned equipment.

- Set-up a zone that isolates areas of contamination from clean areas of the site. All equipment should be decontaminated within the contamination area.
- Employing work practices that minimize contact with hazardous or toxic substances (e.g., avoid areas of obvious contamination, avoid touching potentially contaminated materials);
- Covering monitoring and sampling equipment with plastic or other protective material;

- Use of disposable outer garments and disposable sampling equipment with proper containment of these disposable items;
- Use of disposable towels to clean the outer surfaces of sample bottles before and after sample collection; and
- Encasing the source of contaminants with plastic sheeting or overpacks.

6.1 Decontamination Methods for Direct Sample Contact Equipment

Field personnel should set-up a decontamination line that moves contaminated equipment through the decontamination process to a clean zone. At all stations in the decontamination line, contaminated and/or potentially contaminated fluids and/or wastes are collected and containerized.

Routine decontamination steps for equipment that directly contacts samples are described below.

- 1. Physically remove gross contamination from equipment by abrasive scraping and/or brushing.
- 2. Wash equipment with non-phosphate detergent (i.e., Alconox™ or Liquinox™) in tap water.
- 3. Rinse with tap water
- 4. Rinse with de-ionized water.
- 5. Rinse with 10% nitric acid, if specified in planning documents. Nitric acid washes are typically used for metals contamination.
- Rinse with de-ionized water (if the acid rinse is conducted).
- 7. Rinse with organic solvent(s) to remove high levels of organic contamination, refer to the planning documents for the site/activity-specific solvent choice.
 - Use a methanol rinse to dissolve and remove soluble organic contaminants for high concentration samples.
 - Use a hexane rinse to dissolve waste lubricating oils, tars, and bunker fuels for high concentration samples.
- 8. Air drying
- 9. Rinse with deionized, organic-free water, usually only if alternative solvents are used.
- 10. Wrap sampling equipment in aluminum foil or plastic; if it will not be used immediately. Determine the best material to wrap equipment based on site contaminants for example plastic bags should not be used is sampling for volatile and extractable organics.
- 11. Containerize all solvent rinsing wastes, detergent wastes and other chemical wastes requiring off-site or regulated disposal. Dispose of all wastes in conformance with applicable regulations as defined in the project planning documents.

6.2 Decontamination Methods for Other Equipment and Meters

Several types of sampling equipment such as meters, pumps and tubing that cannot be cleaned directly as described in 6.1. Consult the manufacturers guidelines before decontaminating and equipment.

General decontamination steps are described below.

- 1. Physically remove visible contamination from equipment by brushing the outside of the equipment or wiping with paper towel.
- 2. If tubing or other portions of the equipment comes into contact with the sample then pump any decontamination solvents through the equipment.
- 3. Rinse/or pump with tap water
- 4. Rinse/or pump with de-ionized water.
- 5. Air dry
- 6. Wrap sampling equipment in aluminum foil or plastic; if it will not be used immediately. Determine the best material to wrap equipment based on site contaminants.

6.3 Decontamination Methods for Heavy Equipment

For heavy equipment, a decontamination pad should be established by the driller or subcontractor. Heavy sampling equipment (e.g., augers) decontamination may include a steam cleaning and/or high-pressure water wash step after gross contamination is removed by detergent and brushing.

7 Quality Assurance/Quality Control

Program/project planning documents define the quality assurance/quality control procedures (e.g., collection and analysis of equipment rinsate and other "blanks") necessary to meet program/project DQOs. Typically, a field blank (equipment rinsate blank) consists of a sample of analyte-free water passed through/over a decontaminated sampling device to assess possible cross contamination from equipment to sample contamination.

8 Health and Safety

Personnel review and acknowledge that they understand the project planning documents, especially the SHASP prior to entering the field. Material Safety Data Sheets are taken into the field for hazardous materials used at a site.

Some types of sampling equipment are inherently dangerous pieces of heavy equipment with high pinch or crush potential. Proper handling procedures are followed during decontamination of heavy equipment.

Decontamination procedures may pose hazards, especially when chemical decontamination procedures, high pressure, and/or steam are used. Exposure to hazardous materials or wastes is controlled by the use of appropriate personal protective equipment and proper handling and storage of the materials/wastes, as specified in the project planning documents, especially the SHASP.

Steam cleaning - follow equipment manufacturer operating and safety guidelines.

High-pressure water cleaning - follow equipment manufacturer operating and safety guidelines.

Waste collection and disposal procedures are presented in program/project planning documents and E & E Investigation-Derived Waste SOP.

Avoiding practices that increase tendencies for hand-to-mouth contact including: eating, drinking, smoking, or using chewing tobacco is a basic procedure employed during all field activities.

9 Special Project Requirements

Special project requirements are presented in the program/project planning documents. If required, contract or other client-specific, site-specific requirements may be entered in this section.

10 References

The following list sources of technical information on decontamination procedures.

- ASTM D 5088 02 Standard Practice for Decontamination of Field Equipment Used at Waste Sites, 2008
- USEPA Environmental Response Team "Sampling Equipment Decontamination", SOP #: 2006, REV.#:0.0, 08/11/94
- USEPA Environmental Investigations Standard Operating Procedures and Quality Assurance Manual, Region 4, November 2001
- USEPA Region IV, Field Equipment Cleaning and Decontamination, SESDPROC-205-R2, December 20, 2011
- Navy Environmental Compliance Sampling and Field Testing Procedures Manual, NAVSEA T0300-AZ-PRO-010

END OF SOP

ecology and environment, inc.

STANDARD OPERATING PROCEDURE

SAMPLE PACKAGING AND SHIPPING

SOP NUMBER: ENV 3.16

REVISION DATE: 1/30/2012 SCHEDULED REVIEW DATE: 1/30/2017

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10	References
10	1/C C C ICC3

1 Scope and Application

Liquid and solid environmental samples are routinely collected by Ecology and Environment, Inc. (E & E) during field surveys, site investigations, and other site visits for laboratory analysis. Unless the samples have anesthetic, noxious, or other properties that could inhibit the ability of a flight crew member from perform his or her duty or are known to meet the established United States Department of Transportation (DOT) criteria for hazardous material (i.e., explosive, corrosive, flammable, poisonous), they are not regulated as hazardous materials.

This Standard Operating Procedure (SOP) describes the packaging procedures to be used by E & E's staff to ensure the safe arrival of the samples at the laboratory for analyses. These procedures have been developed to reduce the risk of damage to the samples (i.e., breakage of the sample containers), promote the maintenance of sample temperature within the cooler, and prevent spillage of the sampled material should a container be broken.

In the event the sample material meets the established criteria of a DOT hazardous material, the reader is referred to E & E's Hazardous Materials/Dangerous Goods Shipping Guidance Manual (see http://www.corp.ene.com/departments/health_&_safety/shipping_manual.asp).

2 Definitions and Acronyms

C-O-C Chain-of-Custody

DOT Department of Transportation

VOA Volatile Organic Analysis

3 Procedure Summary

This SOP describes procedures for the packaging of environmental samples in:

- Coolers:
- Steel, aluminum and plastic drums; and
- 4GV fiberboard boxes.

Packaging requirements may vary by state or program and specific requirements should be documented in the planning documents. The United States Environmental Protection Agency (USEPA) Contract Laboratory Program (CLP) Guidance for Field Samplers (USEPA, 2011) provides information on shipping and electronic documentation for the CLP program. The manual also provides good descriptions and figures for packaging samples that is applicable to all projects.

The Hazardous Materials/Dangerous Goods Shipping Guidance Manual will complete the information needed for shipping samples by providing guidance on:

- Hazard determination for samples which meet the DOT definition of a hazardous material;
- Shipping profiles for "standard" shipments;
- Shipping procedures for "non-standard" shipments;

- Marking of packages containing hazardous materials;
- · Labeling of packages containing hazardous materials; and
- Preparation of shipping papers for hazardous materials shipment.

4 Cautions

It is E & E's intent to package samples so securely that there is no chance of leakage during shipment. This is to prevent the loss of samples and the expenditure of funds for emergency responses to spills and the efforts necessary to re-obtain the sample.

Over the years, E & E has developed several "standard" package configurations for the shipping of environmental samples, described below.

Liquid samples are particularly vulnerable. Because transporters (carriers) are not able to know the difference between a package leaking distilled water and a package leaking a hazardous chemical, they will react to a spill in an emergency fashion, potentially causing enormous expense to E & E for the cleanup of the sample material. Therefore, liquids are to be packed in multiple layers of plastic bags and absorbent/cushioning material to preclude any possibility of leaks from a package. This SOP defines the standard packaging configurations for environmental samples.

5 Equipment and Supplies

Coolers and sample labels are typically supplied from the laboratory.

Sample labels can be supplied from the laboratory or purchased commercially

Packaging material such as bags, ice etc are purchased locally

Any durable packaging equipment purchased such as coolers should be labeled with E & E office location and address

The use of absorbent material is not typical. If it is required for a project, then material should be purchased container Supply Company and certified as chemical free.

6 Procedure

6.1 Liquid Environmental Sample Packaging Procedures

Liquid environmental samples should be collected and preserved as outlined in the SOPs for Surface Water Sampling (ENV 3.12) and Groundwater Well Sampling (ENV 3.7). *Preserved water samples are not considered to meet the Hazardous Materials/Dangerous Goods definitions of Class 8 (Corrosive) due to the preservative and are therefore considered to be nonhazardous samples.* Liquid environmental samples may be shipped using an 80-quart cooler or an outer package consisting of either a steel or aluminum drum. Because the steel and aluminum drums provide little insulating capability, they should not be used for samples that require icing.

Packaging Liquid Environmental Samples Using the 80-Quart Cooler

Label and seal all water sample bottles according to appropriate sampling SOPs;

- Secure the bottle caps using fiberglass tape; and
- Place each amber, poly, and volatile organic analysis (VOA) bottle in a sealable plastic bag. Mark the temperature blank "VOA" bag for identification.

If a foam block insert is used:

- Line the cooler with two plastic bags;
- Place a foam insert (with holes cut to receive the sample bottles) inside the plastic bag;
- Place the bottles in the holes in the foam block;
- Fill void spaces with bagged ice to the top of the cooler;
- Fold over the plastic bags lining the cooler and secure shut with tape;
- Place a Chain-of-Custody (C-O-C) form in a sealable bag and tape it to the inside of the cooler lid; and
- Secure the cooler with strapping tape and custody seal. Cover the custody seals with clear tape.

If acceptable absorbent material is used:

- Place 1 inch of inert absorbent material in the bottom of the cooler;
- Line the cooler with two plastic bags;
- Place each sample bottle inside the inner bag;
- Fill the void spaces around the bottles with absorbent to about half the height of the large bottles;
- Fill the remainder of the void spaces with bagged ice to within 4 inches of the top of the cooler, making sure the VOA bottles are in direct contact with a bag of ice;
- Fold over the plastic bags lining the cooler and secure shut with tape;
- Fill the remaining space in the cooler with absorbent to the top of the cooler;
- Place a C-O-C form in a sealable bag and tape it to the inside of the cooler lid; and
- Secure the cooler with strapping tape and custody seal. Cover the custody seals with clear tape.

Note: Acceptable absorbent materials must not react dangerously with the liquid and include vermiculite only if certified asbestos free.

Alternate Packaging Using 1A2/1B2 Drum

- Place 3 inches of inert absorbent material in the bottom of the drum;
- Line the drum with two plastic bags;
- Place each sample bottle inside the inner bag;
- Fill the void spaces around the bottles with absorbent to the height of the larger bottles;
- Fold over the plastic bags lining the drum and secure shut with tape;
- Fill the remaining space in the drum with absorbent to the top of the drum;

- Place C-O-C form in a sealable bag and tape it to the inside of the drum lid; and
- Secure the drum with closing ring and apply custody seals. Cover the custody seals with clear tape.

6.2 Soil/Sediment Environmental Sample Packaging Procedures

Soil/sediment environmental samples should be collected as outlined in the SOP for Soil Sampling (ENV 3.13), and SOP for Sediment Sampling (ENV 3.8). Soil/sediment environmental samples may be shipped using an 80-quart cooler, a 4GV fiberboard combination package, or an outer package consisting of either a steel or aluminum drum. Because the steel and aluminum drums provide little insulating capability, they should not be used for samples that require icing.

Packaging Soil/Sediment Environmental Samples

- Label and seal each sample container according to SOPs;
- Secure the bottle caps using fiberglass tape;
- Place each sample bottle inside a sealable plastic bag and place it in its original shipping box or in individual fiberboard boxes. Mark the temperature blank bag for identification; and
- Secure the original shipping box with strapping tape, place shipping box in a plastic bag, and secure the plastic bag with tape.

If an 80-quart cooler is used:

- Place bubble pack or similar material on the bottom and sides of an 80-quart cooler;
- Place the bagged shipping boxes in the cooler with a layer of bubble pack between each box:
- Fill the void spaces with "blue ice" or ice in baggies to the top of the cooler;
- Place a C-O-C form in a sealable baggie and tape it to the inside of the cooler lid; and
- Secure the cooler with strapping tape and custody seal. Cover the seals with clear tape.

If a 1A2/1B2 drum is used:

- Place 3 inches of inert absorbent material in the bottom of the drum;
- Line the drum with two plastic garbage bags;
- Place the boxes inside the inner bag;
- Fill the space around the samples with absorbent;
- Fold over the plastic bags lining the drum and secure them shut with tape;
- Fill the remaining space around the bags with absorbent to the top of the drum;
- Place the C-O-C form in a sealable bag and tape it to the inside of the drum lid; and
- Secure the drum with the closing ring and apply custody seals. Cover the custody seals with clear tape.

Note: If a small number of samples are being shipped, it may be more practical to package them using the absorbent or foam block configurations used for shipping liquid samples.

6.3 Shipping Procedures

Environmental samples are to be shipped as nonhazardous cargo. Unless the samples have anesthetic, noxious, or other properties that could inhibit the ability of a flight crew member from performing his or her duty or are known to meet the established DOT criteria for a hazardous material (i.e., explosive, corrosive, flammable, poisonous), they are not regulated as hazardous materials. All E & E personnel that package and ship environmental samples or hazardous material must go through E & E DOT training before shipping any samples. When preparing the containers (i.e., cooler, drum, or box) for shipment, E & E staff must remove all labels from the outside container. Labels indicating that the contents may be hazardous are misleading and are not appropriate. Markings indicating ownership of the container, destination, and C-O-C labels are acceptable and can be attached as required.

When completing the paperwork for shipment, the standard nonhazardous forms must be used. Do not use the hazardous materials/dangerous goods airbills, either in total or in part; these forms are coded, and their use will invite unnecessary questions, cause confusion for Federal Express personnel, and delay the sample shipment.

Environmental sample packages can be shipped overnight by Federal Express or equivalent. When planning for sampling activities, check with the companies in advance to verify pick-up and delivery schedules.

7 Quality Assurance/Quality Control

C-O-C forms are provided by the laboratory or can be completed electronically. Samples recorded on the C-O-C form should be checked against the final packaged samples.

Samples shipped on ice require preservation to between 2 and 4°C. Samples that arrived at the laboratory outside this range could have compromised data quality. Samples should be cooled prior to packaging and sufficient ice used to keep samples cool particularly in warm weather. If samples are being shipped for Saturday or holiday delivery, then the availability of personnel should be verified with the laboratory and the shipping documentation checked to verify the appropriate delivery date is noted. Always confirm delivery of the samples with the shipper.

8 Health and Safety

This SOP includes procedures to ensure the arrival of the samples at a laboratory for analyses. These procedures have been developed to reduce the risk of damage to the samples and prevent spillage of the sampled material. Additional health and safety requirements are addressed in the Health and Safety Plan.

9 Special Project Requirements

Special project requirements will be found in the Health and Safety Plan, the quality assurance project plan, and the site-specific sampling plan.

SAMPLE PACKAGING AND SHIPPING SOP: ENV 3.16REVISION DATE: 1/30/2012

10 References

U.S. Environmental Protection Agency, Contract Laboratory Program Guidance for Field Samplers, January 2011, EPA-540-R-09-03.

http://www.epa.gov/superfund/programs/clp/download/sampler/CLPSamp-01-2011.pdf

END OF SOP

ecology and environment, inc.

STANDARD OPERATING PROCEDURE

SURFACE and SHALLOW SUBSURFACE SOIL SAMPLING

SOP NUMBER: ENV 3.13

REVISION DATE: 5/25/2012 SCHEDULED REVIEW DATE: 5/26/2017

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1 Scope and Application

This Standard Operating Procedure (SOP) describes the procedures utilized by E & E for collecting surface and shallow subsurface environmental soil samples. The purpose of soil sampling may range from simple reconnaissance to complex sampling programs. This SOP can be followed for all routine sample collection activities which may include: visual or other observations, in situ or ex situ field measurements (monitoring), or sample collection for biological, chemical, geological, radiological or physical analysis. Site-specific sampling procedures vary depending on the data quality objectives (DQOs) identified in program/project planning documents.

E & E routinely utilizes three types of surface and shallow subsurface environmental soil collection procedures, hand scoop, hand coring, and hand auger. Powered hand augers are sometimes used and the procedure is addressed in this SOP. The definition of the depth of a "surface" soil sample is dependent on the program/project specific DQOs); and may be driven by regulatory, risk-based or other considerations. Hand sampling is generally limited to no more than three feet (one meter) below ground surface. The site-specific depth interval of soil collection is identified in the project planning documents.

Procedures for collecting soil samples for volatile organic compound (VOC) analyses are presented in the E & E VOC Soil and Sediment Sampling SOP ENV 25.

Procedures for collecting "deeper" subsurface soil samples (using back hoes, drill rigs and direct push equipment) are presented in the E & E Borehole Installation Methods SOP GEO 4.7.

Procedures for sample handling are defined in E & E Environmental Sample Handling, Packaging and Shipping SOP ENV 3.16. Site-specific sample handling procedures are dependent on the project DQOs.

Procedures for equipment decontamination are defined in E & E Sampling Equipment Decontamination SOP ENV 3.15. Site-specific equipment decontamination procedures are dependent on the project DQOs.

This surface and shallow subsurface soil sampling SOP is intended for use by personnel who have knowledge, training and experience in the field soil sampling activities being conducted.

2 Definitions and Acronyms

cm centimeter

DQO Data Quality Objective

E & E Ecology and Environment, Inc.

SHASP Site Specific Health and Safety Plan

SOP Standard Operating Procedure VOC Volatile Organic Compound

3 Procedure Summary

Pre-cleaned spoons, trowels, or other types of scoops are used to collect shallow (usually less than 6 inches [15 cm] deep) soil samples using a hand scoop procedure. Shallow subsurface

soil is collected manually using scoops from the sides of hand dug excavations. Pre-cleaned hand soil core samplers and/or bucket augers are used for collecting relatively undisturbed shallow (usually no deeper than 3 feet [1 meter]) subsurface soil samples. The corer barrel/bucket auger is advanced into the soil to the pre-determined depth identified in the project planning documents. In some cases, corers may include a liner on the interior of the core barrel. Soil cores may be sectioned to provide vertical profiles of soil characteristics.

Disturbed soil samples are collected directly from the auger when continuous flight (screw) augers are used

Unless otherwise specified, surface soil scoop aliquots are combined, homogenized and then placed in appropriate sample containers. Volatile organic and sulfide samples are collected immediately after sample retrieval, regardless of the sampling procedure used. VOC samples are not homogenized (see E & E VOC Soil and Sediment Sampling SOP ENV 25) If multiple samples are required to provide the sample volume identified in the project planning documents, then samples are thoroughly homogenized prior to collection of aliquots for testing.

4 Cautions

This SOP is applicable to routine E & E surface and shallow subsurface soil sampling and is limited to relatively shallow soil sampling depths. Hand augers and corers used in this SOP are generally effective only to a maximum depth of 3 feet (1 meter) below the soil surface. The depth of sample collection will be limited if soil is sandy, clayey or rocky. Grass, roots, or other natural or anthropogenic materials may not be considered part to the soil sample.

Because the sampling devices specified within this SOP provide limited sample volumes, multiple samples may be required to collect sufficient volume for sample analysis. Samples from multiple locations also may be collected and composited to provide a sample representative of a larger area. Sample compositing and homogenization should be addressed in the project planning documents. If a compositing scheme is employed and an area(s) is not visually consistent with other areas, then observations should be noted in the field log and a course of action determined based on the program/project DQOs. Samples for volatile organics, sulfide, or similar analyses are normally collected as discrete aliquots and should be containerized as soon as possible after collection and prior to compositing and homogenization. Field personnel must maintain an awareness of the soil sample volume collected versus the volume required to meet program/project DQOs.

Maintaining sample integrity requires selecting a soil sampling device and procedure that meets project DQOs. Carefully following procedures minimizes the disruption of the soil structure and subsequent changes in physiochemical and biological characteristics.

Continuous flight augers are satisfactory for use when a composite of the soil column is desired.

If a powered auger is used, if possible, position the power unit downwind of the sample location to avoid fumes from fuel used to power the unit.

At sites with known or suspected contamination, based on the data available, samples are collected moving from least to most contaminated soil.

Re-use of equipment may be unavoidable given size and cost. Decontamination matched to DQOs is specified in the project planning documents.

Experience has shown that real-world conditions (e.g., variable soil conditions such as the presence of rocks or trash) may lead to unacceptable soil sample recoveries and multiple attempts to collect soil samples will be required at some locations.

Abandon auger and/or core holes according to applicable regulations. Generally, shallow holes can simply be backfilled with the removed soil material.

Standard measures, such as the use of disposable gloves, that meet project DQOs, are used to avoid cross contamination of samples.

As with all intrusive sampling work, project planning should address the potential for encountering subsurface "utilities" and the measures to be taken to avoid problems in the field.

5 Equipment and Supplies

The equipment and supplies required for field work depend on the program/project DQOs. The following is a general list of equipment and supplies. A detailed list of equipment and supplies should be prepared based on the project planning documents. In general, the use of dedicated or disposal equipment is preferred but equipment may be re-used after thorough decontamination between sample locations (refer to E & E Sampling Equipment Decontamination SOP ENV 3.15).

- Stainless-steel or Teflon™ spoons, trowels, or scoops. Other construction material may be acceptable depending upon the program/project planning documents and DQOs
- Stainless-steel mixing bowls. Other bowl construction material may be acceptable depending upon the program/project planning documents and DQOs
- Hand-driven bucket/continuous flight auger(s), split core sampler(s), and single or multistage core sampler(s)
- Rubber mallet or T-bar to help drive hand augers
- Powered auger(s)
- Spade(s) and/or shovel(s)
- Liners and/or catchers for augers or core samplers as specified in the project planning documents
- Pipe cutter(s), stainless steel knives(s), or power saw to cut liners
- Survey stakes or flags to mark locations
- Ancillary equipment and supplies, e.g., meter stick or tape measure, aluminum foil, plastic sheeting, disposable gloves

Supporting equipment and supplies also may be required to address the following:

- Field logbooks and supplies (Refer to project planning documents and the E & E Field Activity Logbooks SOP DOC 2.1 for details)
- Decontamination equipment and supplies (Refer to project planning documents and E & E Sampling Equipment Decontamination SOP ENV 3.15for details)
- Sample containers, preservatives, and shipping equipment and supplies (Refer to project planning documents and the E & E Environmental Sample Handling, Packaging and Shipping SOP ENV 3.16 for details)
- Waste handling supplies (Refer to project planning documents and E & E Handling Investigation-Derived Wastes SOP ENV 3.26 for details)

6 Procedures

E & E staff will use the following procedures for completing soil sampling:

- Review relevant project planning documents, e.g., work plan, sampling and analysis plan, quality assurance project plan, health and safety plan, etc.
- Select the sampling procedure(s) that meet project DQOs.
- Refer to the E & E Field Activity Logbooks SOP DOC 2.1 for guidance on the types of information that should be recorded for each sample.
- Refer to the E & E Environmental Sample Handling, Packaging and Shipping SOP ENV 3.16 for guidance on how samples should be labeled, packaged, and shipped.

6.1 Hand Scoop Surface and Subsurface Soil Sampling

- Surface and shallow subsurface soil samples may be collected by hand using scoops.
- Pre-cleaned spoons, trowels, or scoops are used to excavate shallow soil.
- Sample collection intervals are identified in the project planning documents.
- Clear the area to be sampled of surface debris (e.g., twigs, rocks, and litter).
- Carefully remove the top layer of soil to the desired sample depth with a precleaned tool.
- When sampling from the sides or bottom of an excavation, use a pre-cleaned, scoop, spoon, or trowel to remove and discard the thin layer of soil from the area that came into contact with the shovel or spade.
- Collect sufficient sample volume to meet the DQOs identified in the project planning documents
- Place aliquots to be analyzed for volatile organic analytes and/or sulfides directly into sample containers (i.e., prior to homogenization). Procedures for collecting soil samples for VOC analyses are presented in the (see E & E VOC Soil and Sediment Sampling SOP ENV 25).
- Empty hand-collected samples into a pre-cleaned stainless steel bowl (or other type as specified in the project planning documents).
- If multiple hand collected samples are necessary to collect adequate sample volume, they should all be combined in the bowl prior to homogenization.
- Homogenize the sample(s) as thoroughly as possible.
- Transfer sample aliquots to appropriate sample containers and preserve as required in the project planning documents.
- Return unused soil to the excavation, level the area, replace grass turf as necessary.

6.2 Subsurface Soil Sampling with a Soil Core Samplers

This system consists of pre-cleaned corer barrels (with liners and liner caps, as appropriate), caps, core tips, and slide hammer. The dimensions of the core barrel define the volume and depth interval of possible sample collection. Core sampling is recommended if accurate resolution of sample depths is a DQO. Hand coring will generally be limited to 2-inch diameter – 3 foot (1 meter) long samples.

There are a variety of manual soil core sampling devices available for collecting undisturbed soil core samples. Split core, single core, and multistage core samplers may be used with or without liners that are used to avoid contact between the soil and the corer.

The following procedures are used for collecting soil samples with the soil core sampler:

- Assemble the soil core sampler based on manufacturer instructions and project DQOs (e.g., using a liner and/or catcher).
- Clear the area to be sampled of surface debris (e.g., twigs, rocks, and litter).
- Using the slide hammer or sledge hammer or pounding sleeve, begin driving the precleaned corer into the soil until the desired upper sampling depth is reached.
- Carefully retrieve the corer from the boring.
- Decontamination or replace the core barrel with a pre-cleaned core barrel and resume coring. See E & E Sampling Equipment Decontamination SOP ENV 3.15 for decontamination procedures.
- Soil cores should be extruded or split as soon as possible following collection.
 - o Place core barrel or liner on clean surface
 - Carefully remove end caps and/or catchers
 - Evaluate compaction (core length versus depth of penetration)
 - For transverse sectioning, beginning at the soil surface, measure and mark the sample sections on the outside of the liner
 - Cut the liner with a manual pipe cutter or core liner and core with a decontaminated saw blade into marked sections.
 - Extrude the soil from the cut segments of the liner. If necessary use a plunger cover with aluminum foil to aid in extruding the core.
 - Empty the core segment into a stainless steel bowl (or other type as specified in the project planning documents).
 - Record observations of the soil types.
 - Immediately collect volatile organic analyte and sulfide samples.
 - For longitudinal sectioning, open the split tube or use a knife to cut the liner and expose the upper half of the soil cylinder.
 - Beginning at the soil surface, measure and mark the sample sections using a tape measure set aside the core.
 - Record observations of the soil types.
 - Immediately collect volatile organic analyte and sulfide samples.
 - Scope the core segment into a stainless steel bowl (or other type as specified in the project planning documents).
- If multiple core segments are necessary to collect adequate sample volume, they should all be combined in the bowl prior to homogenization
- Homogenize the sample as thoroughly as possible

- Transfer sample aliquots to appropriate sample containers and preserve as required in the project planning documents.
- Return unused soil to the boring, level the area, replace grass turf as necessary.

6.3 Subsurface Soil Sampling with Bucket Augers

This system consists of pre-cleaned bucket augers, a series of extensions, and a T-handle. The dimensions of the bucket define the volume and depth interval of possible sample collection. The following procedures are used for collecting soil samples with the bucket auger:

- Attach the bucket auger bit to a drill rod extension, and attach T-handle to the drill rod.
- Clear the area to be sampled of surface debris (e.g., twigs, rocks, and litter).
- Begin augering, periodically removing and depositing accumulated soils onto a plastic sheet spread near the hole until the desired upper sampling depth is reached.
- Decontaminate the bucket auger or replace the bucket auger with a pre-cleaned auger bucket and resume augering. After reaching the desired depth (no more than the maximum length of the auger bucket), carefully remove the auger from the boring.
- Empty bucket auger-collected samples into a pre-cleaned stainless steel bowl (or other type as specified in the project planning documents) OR use pre-cleaned scoops and carefully subsample soil from within the bucket that has not come in contact with the auger.
- Immediately collect volatile organic analyte and sulfide samples.
- If multiple bucket auger collected samples are necessary to collect adequate sample volume, they should all be combined in the bowl prior to homogenization.
- Homogenize the sample(s) as thoroughly as possible.
- Transfer sample aliquots to appropriate sample containers and preserve as required in the project planning documents.
- If another sample is to be collected in the sample hole, but at a greater depth, decontaminate or re-attach a pre-cleaned auger bucket, and follow steps above.
- Return unused soil to the excavation, level the area, replace grass turf as necessary

6.4 Subsurface Soil Sampling with Continuous Flight Augers

This system consists of pre-cleaned continuous flight augers, a series of extensions, and a Thandle. The dimensions of the flight define the volume and depth interval of possible sample collection.

When continuous flight augers are used, the sample can be collected directly off the flights. Continuous flight augers are satisfactory for use when a composite of the soil column is desired.

A powered auger may be used at this time. The following procedures are used for collecting soil samples with an auger:

- Attach the continuous flight auger to a drill rod extension, and attach T-handle to the drill rod.
- Clear the area to be sampled of surface debris (e.g., twigs, rocks, and litter).

- Begin augering, periodically removing and depositing accumulated soils onto a plastic sheet spread near the hole until the desired upper sampling depth is reached.
- Decontaminate or replace the auger flight with a pre-cleaned auger flight and resume augering. After reaching the desired depth (no more than the maximum length of the auger flight), carefully remove the auger from the boring.
- Place auger-collected samples into a pre-cleaned stainless steel bowl (or other type as specified in the project planning documents) OR use pre-cleaned scoops and carefully subsample soil from within the auger flights as it comes to the surface.
- Immediately collect volatile organic analyte and sulfide samples.
- If multiple auger flight-collected samples are necessary to collect adequate sample volume, they should all be combined in the bowl prior to homogenization
- Homogenize the sample(s) as thoroughly as possible.
- Transfer sample aliquots to appropriate sample containers and preserve as required in the project planning documents.
- If another sample is to be collected in the sample hole, but at a greater depth, decontaminate or re-attach a pre-cleaned auger flight, and follow steps above.
- Return unused soil to the excavation, level the area, replace grass turf as necessary.

7 Quality Assurance/Quality Control

Prior to initiating field work, the project planning documents (e.g., work plan, sampling and analysis plan, quality assurance project plan, SHASP, *et al*) should be reviewed by field personnel to identify sampling procedure(s) that will most likely provide surface and shallow subsurface soil samples that meet project DQOs.

The program/project manager should identify personnel for the field team who have knowledge, training and experience in the field soil sampling activities being conducted. One member of the field team should be designated as the lead for soil sampling and will be responsible, with support from other field personnel, for implementing the procedures in this SOP. The program/project manager should also identify additional personnel, if necessary, to complete ancillary procedures, e.g., field logbook documentation, equipment decontamination, sample shipment, and waste disposal.

The soil sampling lead should prepare a detailed equipment checklist before entering the field and verify that sufficient and appropriate equipment and supplies are taken into the field.

Quality assurance/quality control samples (e.g., co-located samples) are collected according to the site quality assurance project plan. Field duplicates are collected from one location and treated as separate samples. Field duplicates are typically collected after the samples have been homogenized. Collocated samples are generally collected from nearby locations and are collected as completely separate samples.

In cases where multiple hand-collected scoop, auger or core samples are required to generate an adequate sample volume, homogenization is important. Field personnel should collect sample aliquots only after mixing has produced soil with textural and color homogeneity.

At sites with known or suspected contamination, samples should be collected moving from least to most contaminated areas.

8 Health and Safety

Prior to entering the field, all field personnel formally acknowledge that they have read and understand the project specific health and safety plan.

Augers and soil core sampling apparatus are inherently dangerous pieces of heavy equipment which a high "pinch" potential. Care should be taken at all times when handling such equipment, not just during sample collection.

Prior to any subsurface work, verify that underground utilities have been located and marked.

9 Special Project Requirements

Project or program-specific requirements that modify this procedure should be entered in this section and included with the project planning documents.

10 References

The following list sources of technical information on soil sampling.

- Barth, D. S. and B. J. Mason, 1984, *Soil Sampling Quality Assurance User's Guide*, EPA-600/4-84-043.
- de Vera, E. R., B. P. Simmons, R. D. Stephen, and D. L. Storm, 1980, *Samplers and Sampling Procedures for Hazardous Waste Streams*, EPA-600/2-80-018.
- Navy Environmental Compliance Sampling and Field Testing Procedures Manual, NAVSEA T0300-AZ-PRO-010
- U.S. Environmental Protection Agency (EPA), 1985, Characterization of Hazardous Waste Sites A Methods Manual: Volume II, Available Sampling Methods, (2nd ed.), 1985, EPA-600/S4-84-076.
- ______, 1995, Removal Program Representative Sampling Guidance: Volume I Soil, (Interim Final), EPA-9360.4-10.
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 - _____, February 1989, *Methods for Evaluating the Attainment of Cleanup Standards:* Volume I, Soils and Solid Media, EPA/230/02-89/042.
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 - _____, 18 February 2000, U.S. EPA Environmental Response Team Standard Operating Procedures, Soil Sampling, SOP #2012

END OF SOP





MEASURING WATER LEVEL AND WELL DEPTH

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1. Introduction

This document describes E & E's standard operating procedure (SOP) for measuring water level and well depth in monitoring wells and piezometers.

2. Equipment

The following is a list of equipment and items typically used for measuring water level and well depth:

- Electronic water level indicator with graduated cable measured at increments of 0.1 and 0.01 foot;
- Plastic sheeting; and
- Folding ruler or pocket steel tape.

3. Procedure

3.1 Preliminary Steps

- 1. Locate the well or piezometer and verify its position on the site map. Record whether positive identification was obtained, including the well number and any identifying marks or codes contained on the well casing or protective casing. Gain access to the top of the well casing and note the date and time the well was opened. If specified in the work plan or site health and safety plan, use monitoring equipment to measure or take readings of the well headspace. Record all measurements and observations (e.g., odor).
- 2. Locate and record the specified benchmark or survey point for the well or piezometer, which may be a mark at the top of the casing or a surveyor's pin embedded in the protective structure. Determine the elevation of this point from the records and record in the notebook. Measure and record the vertical distance from the benchmark to the top of the well casing to the nearest 0.01 foot. Measure and record the metal casing stickup (i.e., the distance between the top of the casing and nominal ground level).



TITLE:	MEASURING WAT	ER LEVEL AND W	ELL DEPTH
CATEGORY:	GEO 4.15	REVISED:	March 1998

- 3. Record any observations and remarks regarding the completion characteristics and well condition, including evidence of cracked casing or surface seals, security of the well (locked cap), and evidence of tampering.
- 4. Keep all equipment and supplies protected from contamination with clean plastic sheeting. Keep the water level indicator probe in its protective case when not in use.

3.2 Operation

- 1. Remove the water level indicator probe from the case, turn on the sounder, and test-check the battery and sensitivity scale by pushing the red button. Adjust the sensitivity scale until you can hear the buzzer and see the red indicator light.
- 2. Slowly lower the probe and cable into the well, allowing the cable reel to unwind. Continue lowering until the meter buzzes. Raise and lower the probe very slowly until the meter begins to buzz continuously. Mark the spot by grasping the cable with the thumb and forefingers at the top of the casing, withdraw the cable, and record the depth.
- 3. To measure the total well or piezometer depth, lower the probe until slack is felt in the cable. Very slowly raise and lower the cable until the exact bottom of the well is detected. As before, grasp the cable with the thumb and forefinger at the top of the casing and note the depth. If a water level probe, such as the Solinst, is used to measure total depth, the weight of the probe will likely extend approximately 6 centimeters beyond the calibrated "zero" point of the measuring cable. If this is the case, use the cable to accurately measure the distance from the end of the weight to the point of the needle (in the "window" of the probe) and add this length to the depth noted above. Record the sum of these two lengths as the total depth of the well.
- 4. Withdraw the cable and probe, and decontaminate according to the SOP for Equipment Decontamination (ENV 3.15).

3.3 Data Recording and Manipulation

Record the following computations:

- Casing elevation = bench mark elevation + casing stickup
- Water level elevation = casing elevation depth of water
- Well bottom elevation = casing elevation depth to bottom
- Total well depth = cable-measured depth + length of the weight extension





4. Calibration

No calibration is needed for the electronic water level indicator.

5. Precautions

Because some casings have rough or sharp edges, use caution when lowering and retrieving the water level cable from within the well casing. These edges can cut and scrape the cable, obscuring the calibrated markings on the cable, and can eventually lead to failure (shorting out) of the electronic cable.

Always use caution when opening capped wells, because escaping (venting) headspace gases may be hazardous.





Supplemental Sample Documentation Forms





USEPA Contract Laboratory Program Organic Traffic Report & Chain of Custody Record

1. Case No.:		
DAS No.:		K

2. Region:		3. Date Shipped:		4. Chain of Custody Record			Sampler Signature:			
Project Code:				Carrier Name:		Relinquished By: (Date/Time)		Received By: (Date/Time)		
Account Code:				·			neu by.	(Date/Time)	Received by:	(Bate) Time)
CERCLIS ID:				Airbill:		1)				
Spill ID:				Shinn	ped To:	2)				
Site Name/State:				Simple	Jeu 10.					
Project Leader:						3)				
Action:						4)				
Sampling Co.:										
5. ORGANIC SAMPLE No.	6. MATRIX SAMPLE	7. TYPE R	8. ANALYSI TURNARO	S/ UND	9. TAG No./ PRESERVATIVE/Bottles		10. STATION LOCATION	11. SAMPLE COLLECT DATE/TIME	12. INORGANIC SAMPLE No.	13. QC Type
14. Shipment for Complete?	Case 15.	Sample(s) to	be used for	aborat	tory QC: 16. Additional Sampler S	ignature(s)	:		17. Chain of Custo	dy Seal Number:
18. Analysis Key: Type: Comp, Grab (from Box 7)								19. Shipment Iced	1?	



USEPA Contract Laboratory Program Inorganic Traffic Report & Chain of Custody Record

1. Case No.:		
DAS No.:	R	

2. Region:		3. Date Shipped:		4. Chain o	f Custody Re	cord	Sampler Signature:				
Project Code:					Canni	an Nama	Relinquished By: (Date/Time)			Received By: (Date/Time)	
Account Code:					Carri	er Name:	(Date/Time)			Received by.	(bate) Time)
CERCLIS ID:					Airbi	II:	1)				
Spill ID:				Chine	ped To:	2)			 		
Site Name/State:					Suibt	ped 10:					
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14. Shipment for Complete?	Case 15	. Sam	ple(s) to	be used for I	abora	tory QC: 16. Additional Sampler S	ignature(s)	:		17. Chain of Custo	ody Seal Number:
18. Analysis Key: Type: Comp, Grab (from Box 7)										19. Shipment Ice	i?

Date: GEN Signature: **REGION 10 REGION 10**

